PRIL, 1947 TECHNOLOGY [illegible] TWO SHILLINGS

Plastics

EALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

APR 30 1947

HE MICANITE & INSULATORS CO., LTD. EMPIRE WORKS, BLACKHORSE LANE, WALTHAMSTOW, LONDON E.1

Take thou this flower . . . . . .

Take it, if you will, as an artist's whim . . . inspired by the colourfulness of knitting pins made from Lactoid. Accept it as a reminder of the important place of BX Thermo Plastics in modern production.

'Xylonite' (Celluloid) 'Bexoid' (Cellulose Acetate) 'Lactoid' (Casein) B.X. P.V.C. (Polyvinyl Chloride) 'Distrene' (Polystyrene) 'Isoflex' (Lightweight Thermal Insulation) B.X. Ethyl Cellulose

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'Sorry to let you down, chaps . . . Got an idea that will pull! — make it of rubber, of course! . . . Simply must speak to Lorival NOW.'

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★ *While each material possesses its own characteristics, in many applications one is as suitable as the other, and in these times of scarcity it is as well to have this in mind. Firms in need of components, complete articles or packaging should seek our advice, which is based upon wide experience and specialized knowledge. We produce articles in rubber as well as plastics, and our service includes design and manufacture.*

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STEAM GENERATED ... 37/- per ton

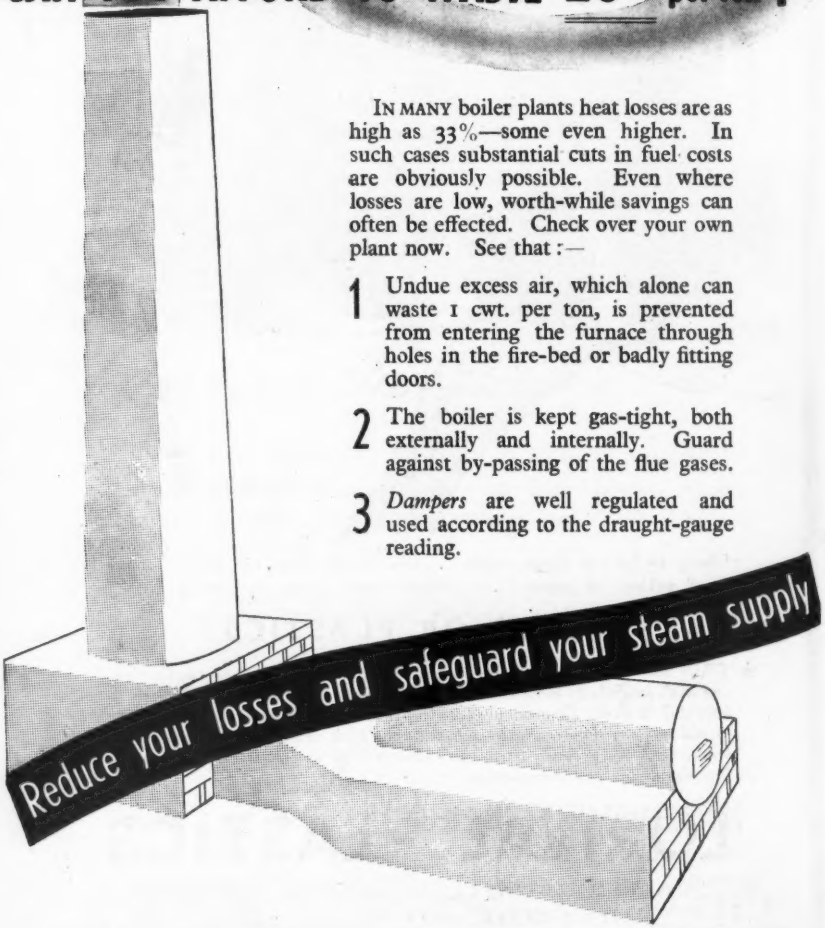
CAN YOU AFFORD TO WASTE 26/- per ton ?

IN MANY boiler plants heat losses are as high as 33%—some even higher. In such cases substantial cuts in fuel costs are obviously possible. Even where losses are low, worth-while savings can often be effected. Check over your own plant now. See that :—

1 Undue excess air, which alone can waste 1 cwt. per ton, is prevented from entering the furnace through holes in the fire-bed or badly fitting doors.

2 The boiler is kept gas-tight, both externally and internally. Guard against by-passing of the flue gases.

3 *Dampers* are well regulated and used according to the draught-gauge reading.



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For the greater convenience of their Trade friends and to meet the constantly increasing demand for their well known Brake and Clutch Linings, Messrs. Ferodo Limited have acquired new and more commodious premises at

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FERODO LIMITED · CHAPEL-EN-LE-FRITH

PLASTICS *and the Ashdowns Organization —*

TESTING THE PRODUCT

Our laboratory is divided into three sections, each essential to the making of a plastic product of top quality. All raw materials which enter the factory are tested in the first laboratory section. Researches into new materials and the development of new methods of production are carried out in the second section, the finished product coming under mechanical and electrical tests in the third section before dispatch to the client. It is by such methodical supervision that we have delivered the goods for twenty years.

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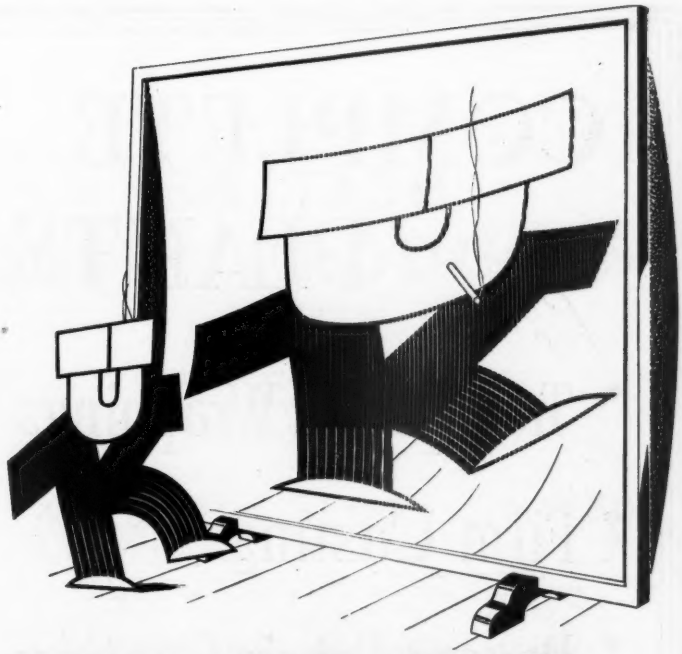
Ashdowns is a subsidiary of Pilkington Brothers Limited



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We have long realised the future possibilities of Plastics, and all our energies are devoted to their development and application in many new directions . . . . a broad outlook we agree . . . . but one that is necessary if we are to give you the most modern practice in Plastics.

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Once again the world-famous British Industries Fair will enable the buyer, after a lapse of seven years, to establish direct contact with his suppliers and to discuss his marketing problems in person with the actual manufacturer.

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THE PUBLIC — Hours of admission to the Public at Olympia and Earls Court are limited for the convenience of Home and Overseas Buyers:—Monday to Fri. 4.30 p.m.—7.30 p.m. Sat. 9.30 a.m.—7.30 p.m. Birmingham Section open to the Public 10 a.m. — 6 p.m. daily. Admission 2/6.

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Synthetic Rubber

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The following grades will shortly be available

Hycar	OR-15	For super oil resistance
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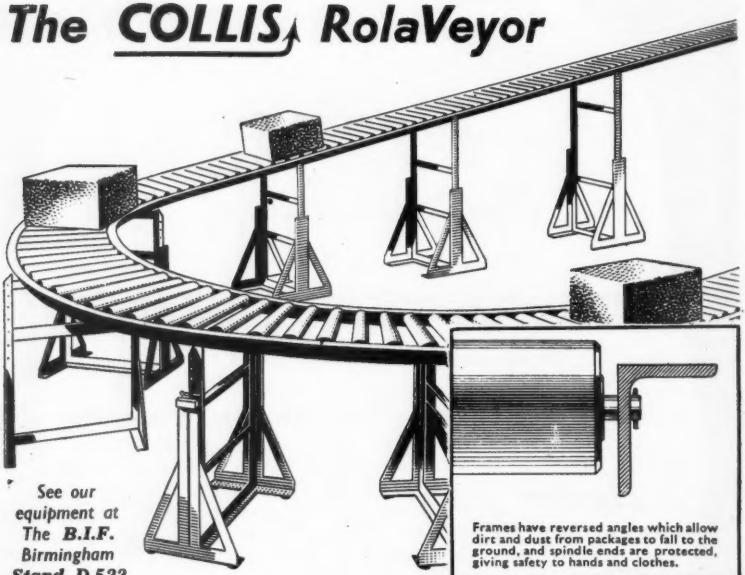
an improved Gravity Roller Conveyor

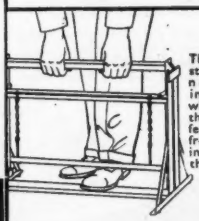
The COLLIS RolaVeyor



See our equipment at The ***B.I.F.*** *Birmingham* ***Stand D.522***

Frames have reversed angles which allow dirt and dust from packages to fall to the ground, and spindle ends are protected, giving safety to hands and clothes.

By reversing the longitudinal members of the frame, operatives are enabled to erect the RolaVeyor without the risk of trapped fingers.



The adjustable stand design has new safety improvements which make sure that hands and feet are free from risks during erection of the equipment.

The Collis RolaVeyor is a simple assembly of units, consisting of straights, curves, adjustable stands, which can quickly be erected by your own staff to form a fast moving transfer system between any two or more points in your factory or warehouse. Cases, crates, chests, trays, pallets, pans, churns, tote boxes, bricks, sawn timber, etc., given a slight gradient, glide easily to their destinations without the use of manpower. It costs virtually nothing to operate—it saves time and labour at every move.

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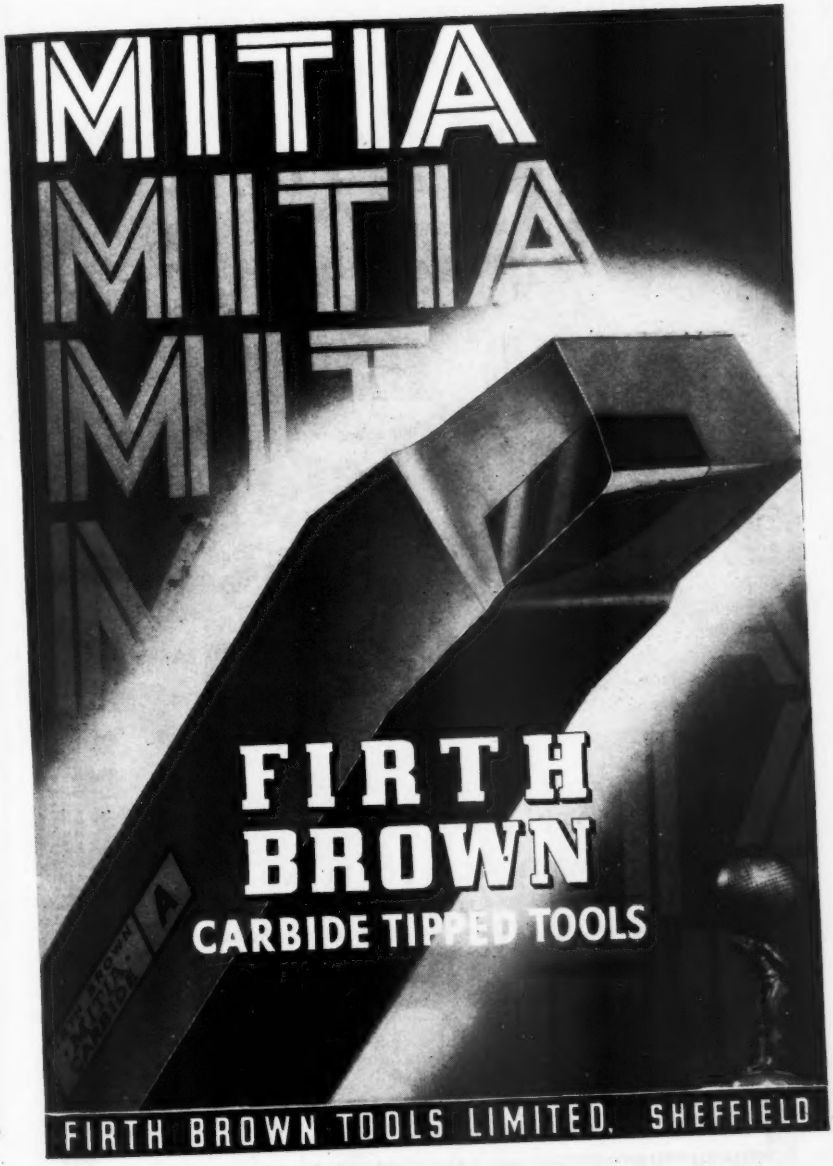
The COLLIS RolaVeyor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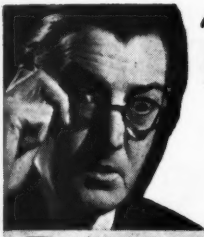
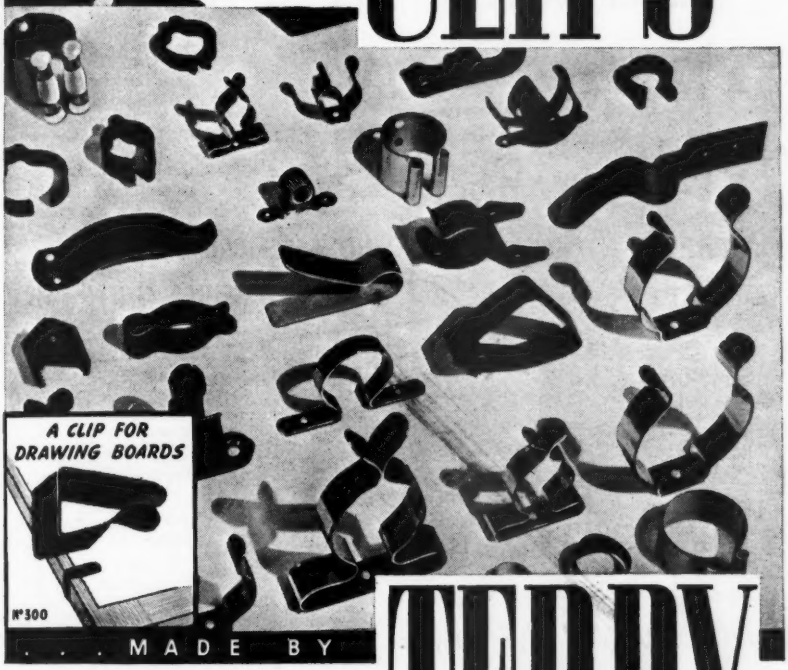


"I never knew there were so many kinds of...

CLIPS"



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(*infra-red*)

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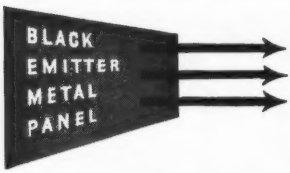
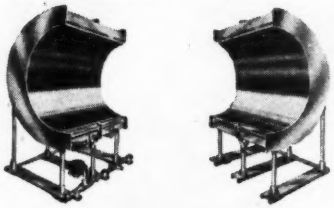
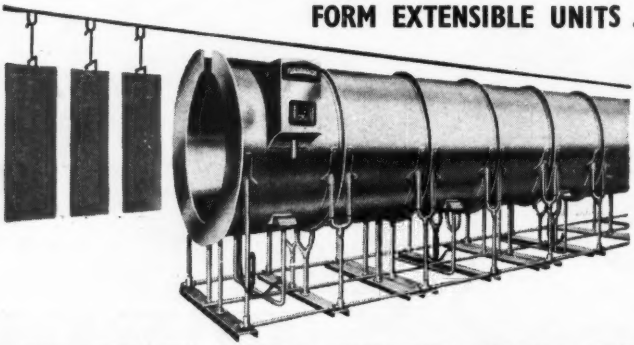


USE IT IN A UNIT LIKE THIS . . .



EQUIP IT WITH GAS-FIRING AND ASSEMBLE TO FORM EXTENSIBLE UNITS . . .



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Robust, compact, inexpensive . . . easily constructed in different shapes and sizes without complicated auxiliary apparatus . . . giving even distribution of radiation and wide range of flux density at the turn of a tap . . . no material difference in drying time due to colour . . . low capital and fuel costs. Technical literature free on request.

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A 50 TON HYDRAULIC PLASTICS PRESS THAT IS COMPLETELY

Self-contained

THE Turner Plastics Press is complete in itself. It contains its own hydraulic system and electrical heating system, and is installed simply by making a single connection to the electrical supply. It combines the uses of many presses by providing any required pressure between 10 and 50 tons. Operation is by a single lever which gives complete control over ram travel and speed at any point of the stroke. Occupies only 6 sq. ft. of floor space. Mechanically interlocked safety guards are fitted as standard. Mechanical ejectors supplied if required; bottom ejectors have manual resetting which can be operated without moving the ram. Illustrated literature gladly sent on request.

SIMPLE TO OPERATE.
One lever controls both opening and closing movements of the press.

SIMPLE TO INSTALL.
A single connection to the electrical supply and the press is ready for operation

The TURNER PLASTICS PRESS

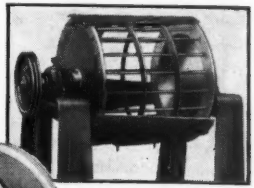
TURNER MANUFACTURING CO., LTD., WULFRUNA WORKS, VILLIERS ST., WOLVERHAMPTON.

Rings of Linatex Rubber

UNDER COMPRESSION

form the drum of this remarkable new Ball Mill

This fine new Wilkinson product gives Engineers a Ball Mill of adequate strength and exceptional abrasive resistance. Instead of a metal drum lined with porcelain or rubber, the barrel of this new Ball Mill consists entirely of rings of Linatex Rubber compressed together (the ideal condition for maximum durability and abrasive resistance) and held immovably in place by tie rods embedded in the rubber itself. Metallic contamination of contents is impossible, and the whole Ball Mill combines lightness with robust structural design. Note the special quick-release hand hole.



UNITS COMPLETE with motor and reduction gear, or for line shaft drive. Replacement drums supplied for existing units. Sizes 1′ 0″ dia. to 3′ 0″ dia. Speeds: to suit customers requirements.

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Highly recommended for use in such industries as:–

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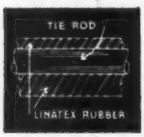
OLD METHOD

Consists in bonding, or fixing mechanically, a rubber lining to the internal surfaces of the drum.

NEW METHOD

The new Wilkinson development is a scientific combination of rubber and metal.



The new

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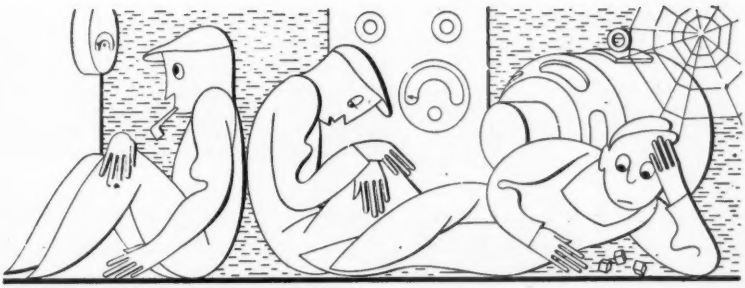
Also makers of Flexatex Hose, Linatex, Novatex, and the Linatex Pump.

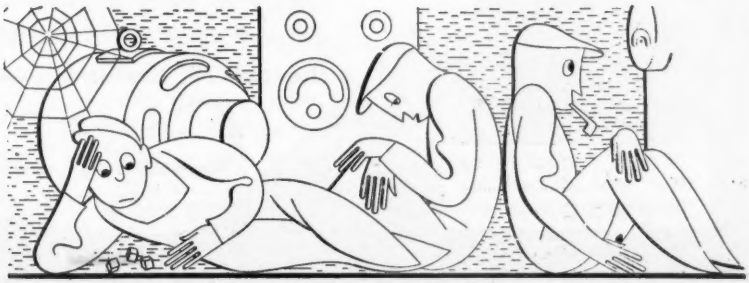


Design For *Industrial* Freeze

Some said the Tories diverted the Gulf Stream. An official of the MINISTRY OF FUEL AND (if lucky) POWER said it was just a laughable mistake in a number of noughts. The MINISTRY OF TRANSPORT said the points froze—and the Housewives cried Hear, Hear. The Minister said perhaps it was a blessing in disguise. People in production had to revert to hand tools but point out, *just in case* it should happen again, that a little electricity goes a very long way with Desoutter Electric Tools.

Specialists in Lightweight, Pneumatic and Electric Portable Tools.

DESOUTTER



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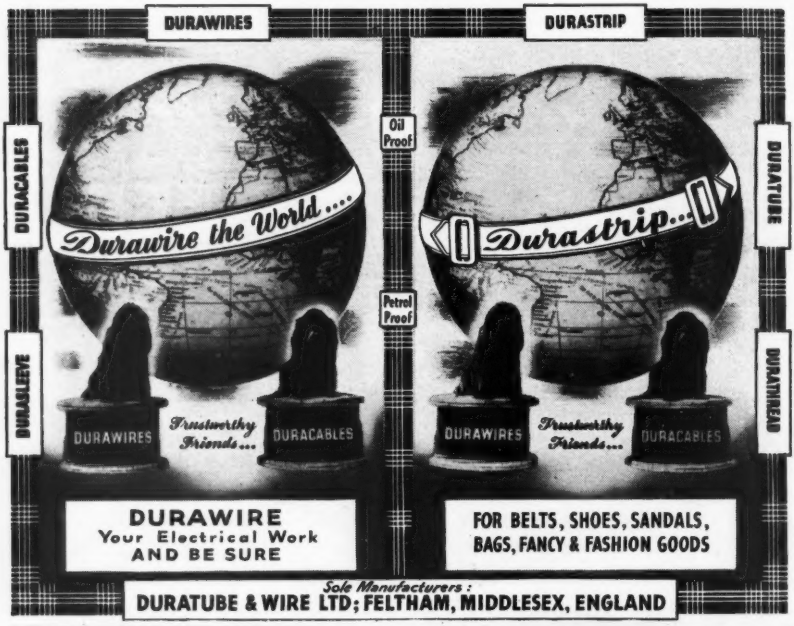
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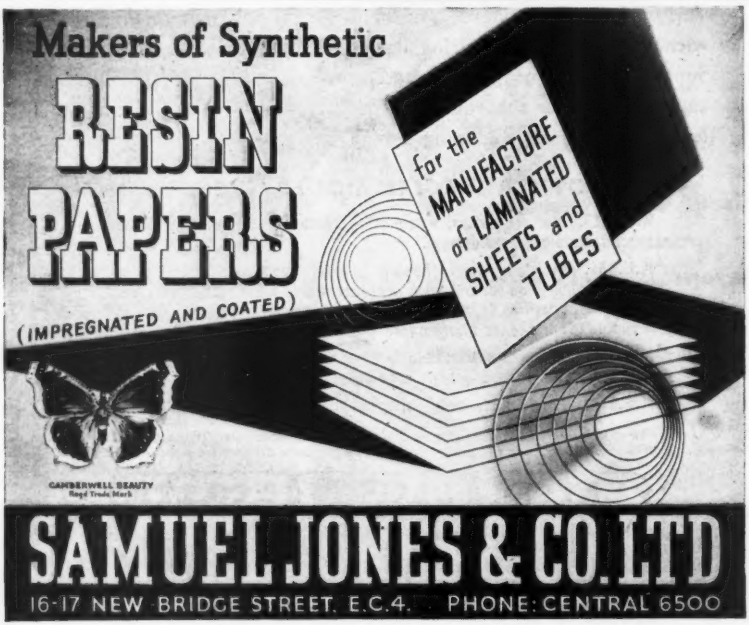
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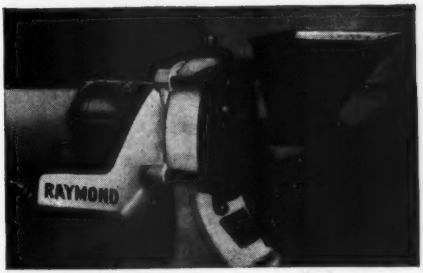
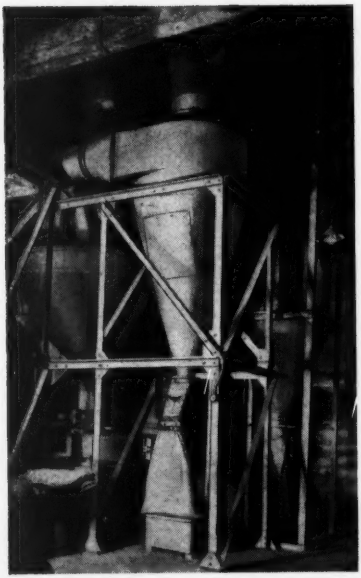
ozs per minute...

For real commercial results on a small scale, for short test runs and samples the compact little Raymond Laboratory Mill is just the job. Plug it in to the nearest electric switch and see how quickly it pulverises several pounds of material at a time to the required degree of fineness. An ever-useful standby in any Lab. Five interchangeable screens; speed 10,500 r.p.m. ½ H.P. Universal Motor.



or tons per hour...



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Point TWO

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Co-operation in the early stages of the design of the piece is important.

Modern plastic materials are infinite in their variety and characteristics and to consult specialists is but a simple precaution in the interests of ultimate satisfaction.

Crystalate's "fit for the job?" moulding service will clarify all difficult points for you.

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IN THE PLASTIC WORLD

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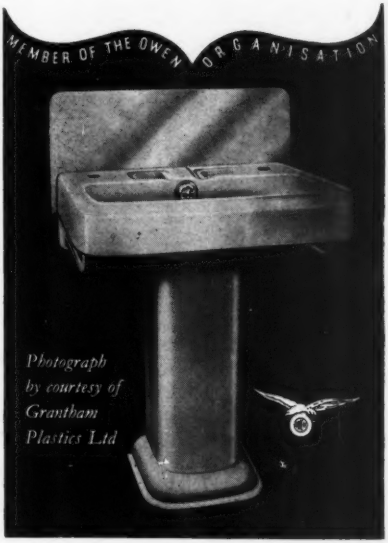

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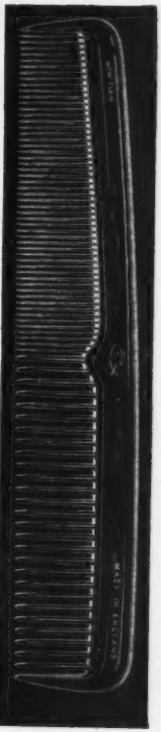

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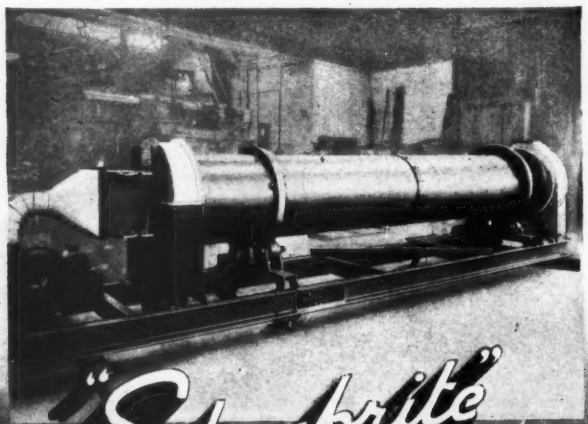

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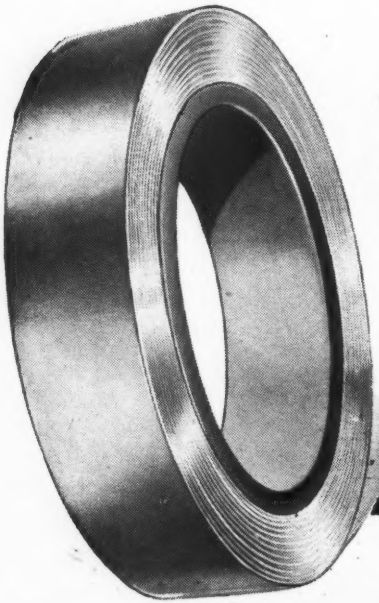

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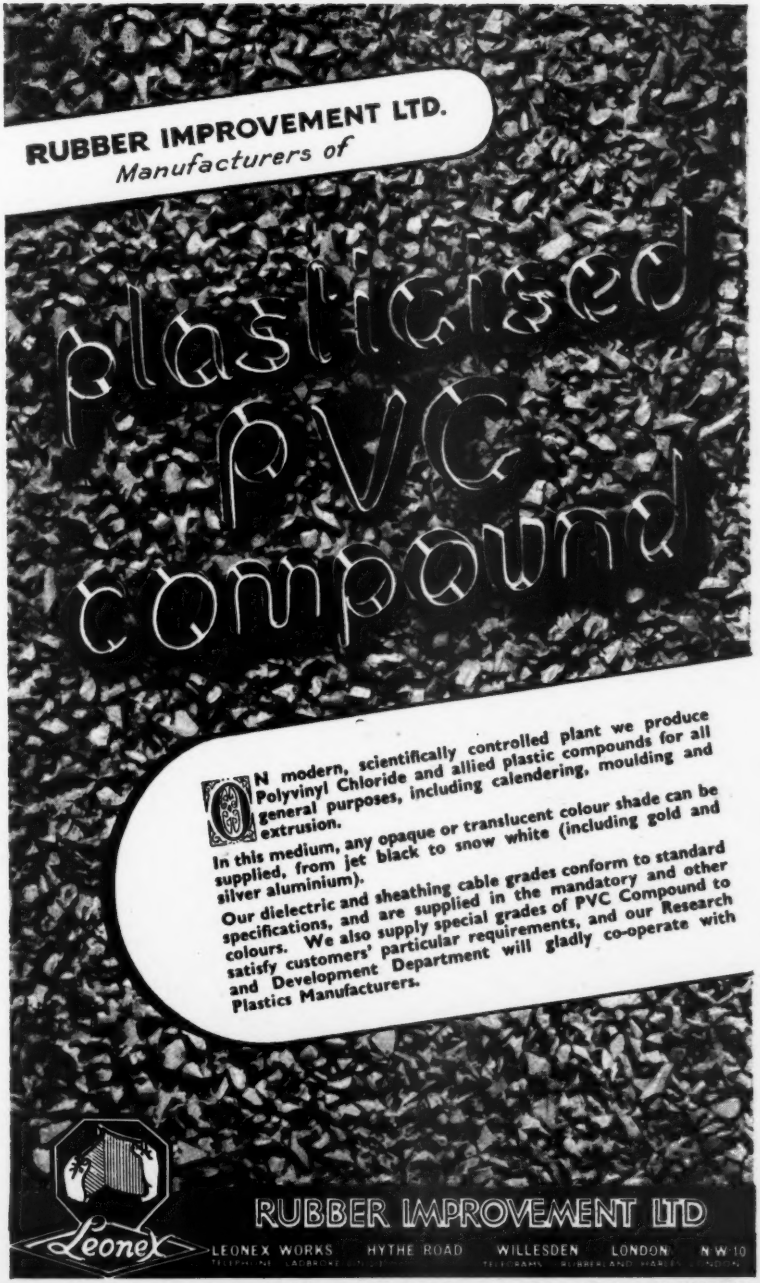
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Vol. XI. No. 119. APRIL, 1947

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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NOTICES

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EDITORIALS

Our Raw Materials from Petroleum

THE safety of our industry as regards supplies of raw materials is a subject of overwhelming importance, never more so than during the current year, when, two years after the cessation of war, we have to swallow the humiliation of shortages of chemicals such as phenols, ureas and, of all things, formaldehyde.

There is, however, a brighter future before us. Not only will such shortages pass, but we are on the eve of one of the greatest strides we have taken as a nation to ensure the future of our chemical industry, on which our own industry depends so much.

In our January issue we wrote on a subject which we have repeated *ad nauseam*, namely, chemicals from petroleum, and hinted at coming developments by yet another petroleum company.

The Shell Petroleum Company has now made a full announcement of its future activities, and very promising they are. They include a new plant at Thornton-le-Moors in Cheshire and an extension of the existing plant at Stanlow on the Manchester Ship Canal.

Whilst no direct manufacture of cyclic compounds and, therefore, phenolics is suggested (the Manchester Oil Refinery Ltd., will produce these types), the range of solvents that will be produced for the plastics industry is most impressive. Of these, acetone, diacetone alcohol, isopropyl alcohol, methyl ethyl ketone, butyl alcohols, and mesityl oxide are of great importance in the formulation of surface castings based on cellulose esters of all types and for dissolving the vinyl resins. Acetone is the source of the methacrylates and of what we have not seen manufactured yet, the acetone resins. Methyl ethyl ketone and formaldehyde condense to form interesting resins, whilst from tertiary butyl alcohol is produced complex phenols for making valuable thermosetting resins.

Another interesting series of compounds is Dutrex, aromatic viscous fluids, which act as plasticizers for p.v.c., especially valuable because of their very high boiling points.

In addition to the initial range of petroleum chemicals to be made at Thornton, a wide range of development chemicals of interest to the plastics industry will come into large-scale production at a later stage.

Particular interest focuses on diallyl phthalate at the starting point for making colourless zero pressure thermosetting resins for castings, laminates and tiles.

At present much of these compounds comes from the United States. It is estimated that the output of the Thornton plant will mean a reduction in imports from America of 4,000,000 dollars a year.

It is of considerable satisfaction to us that, at last, Great Britain is approaching a situation we have ardently awaited for over 20 years, where she will at last surpass Europe (meaning Germany) in output as regards quantity and will equal the U.S.A. in variety although not capacity of chemical manufacture. With it will come more research and more results, and with it too we shall see an expansion in our chemical engineering and precision instrument industries. All these are fundamental to our future welfare.

The Contact Resins

THE plastics industry is indeed an industry of rapid changes and surprises.

About five or six years ago we congratulated Mr. Herbert Bridge, of De La Rue Plastics, Ltd., for daring to make (at an early "Plastics Quiz," we believe it

was) the challenging statement that if he thought there would be no resins capable of cure at low temperatures he would not be in the plastics industry. Perhaps he did not mean all he said, but as an example of prophecy it was outstanding. While some of the "brains" at the "Plastics Quiz" were very doubtful of the possibility, we also indulged in some wishful thinking.

It was about two years later that a Canadian visitor to this office showed us what was one of the early examples of allyl resins and mentioned the likelihood of making laminates with such resins and with no pressure at all. Since then we have heard much about them. On March 11, Dr. E. G. Williams, of I.C.I. (Plastics Division), told the whole story to date.

The resins are in four classes, allyl, alkyd, acrylic and vinyl, and are used almost solely in the production of laminates at ordinary atmospheric pressures, although pressures up to 50 lb. per sq. in. are also used.

The saving of special equipment is obvious and also the process is most suitable for making "sandwich" laminates and large articles, such as boats, canoes and furniture without difficulty, and using the rubber bag technique. The resins are also most suitable for use with woven glass-fibre cloth, which provides laminates with great strength.

While the materials are not in ready supply in this country, they obviously have as great a future as any in industry.

Our Coal

IN 1946 we exported between 9 and 10 million tons of coal which should have remained in this country to build up our stocks for fuel purposes or for the manufacture of chemicals, a noteworthy portion of which would have gone to our growing plastics industry. As a result of this brilliant piece of export business, which Mr. Shinwell has so ardently desired for the quick return of some 20 million pounds, we shall be worse off this year than ever during the war, and deprived of the chance of turning the coal into material many times its value. Only when our own needs are satisfied should export be considered.

Welcome Visitor

WE were delighted to receive at this office during the past month an old friend, Mr. Islyn Thomas, President of the Thomas Manufacturing Corporation of Newark, New Jersey, U.S.A., who has

Mr. Islyn Thomas.

wafted a warm and gentle zephyr across the winter of our discontent.

Islyn Thomas is, or perhaps we should say was, a Welshman who went as a youth over 20 years ago to the States, has become an engineer of repute, and is the head of a well-known company specializing in the field of injection moulding. We shall have the pleasure of publishing from time to time some of his productions in plastics.

In 1945 he was over here to visit his relations in South Wales, to contact

various acquaintances, business and otherwise, and to gather information for the compilation of a book he was writing on injection moulding.

This year he has come to renew business acquaintances, to arrange production here of certain of his designs and to show us the galley proofs of his book which is being produced by Reinhold in the U.S.A. and probably by Chapman and Hall here.

This book of his is not only packed full of the most detailed information on the subject of modern injection moulding, on all the important latest machines in the U.S.A. and here, and on workshop layout and procedure, which alone make it a unique compilation, but it also makes a fascinating study of the whole history of the subject beginning with the injection of celluloid by Hyatt.

We were able to pull Mr. Thomas's leg slightly during his visit, for he, in his book, like most Americans, plumps for Hyatt as the discoverer of celluloid.

On the other hand, we were able to prove, to our own satisfaction, at any rate, that D. Spill and A. Parkes, two Englishmen, were a few years ahead of Hyatt. Having now taken this very important international problem to such high levels we are sure we can leave it safely in Mr. Thomas's hands.

Injection Machine Age

OUR visitor gave us four important sets of figures for injection machines which will start many of us thinking seriously. They are as follow: some slight doubt of accuracy is expressed over the 1940 figures.

U.S.A. Machines and Production

Year.	Number of Machines.	Millions of Dollars.
1940	450 (?)	13½ (?)
1943	1,300	43
1945	1,600	55
1946	3,200	56

Most startling is the extremely high number of these mass-production machines in the U.S.A., and it must be further remembered that among them there is a high proportion of large-capacity type, big mouldings being quite common. One of the newest machines produces an 80 oz. moulding of a Ford steering wheel.

Also startling, and disquieting, are the last two sets of figures, which mean, roughly, that about half of the machines have not been working and that there has been over-production. This is obviously a serious affair, but American resilience will no doubt overcome the trouble. On the other hand, we earnestly hope that the fall in demand, for such there undoubtedly has been, is not due to a change in America's attitude towards plastics.

In this country such violent fluctuations are almost impossible, for the brake of conservatism, sometimes a cursed thing, also acts in a beneficent way. A very rapid increase in the number of machines is always unlikely, quite apart from production difficulties, and rapid increase in large-capacity types is also doubtful. Production is generally fairly close to capacity. Nevertheless we must learn the lesson of the above figures, one part of it which is not very visible being that quality and design must be of the highest. When this is done the public will not let the industry down.

Mr. Thomas in his book mentions another factor which has a very direct bearing on this problem, namely, that the very small injection moulding machine has a very important role in the workshop, and in effect says that it is useless carrying out small jobs and small runs on a big machine. In his broad-minded way he picks out for special praise the new small Westminster machine made by Dowding and Doll, Ltd., of this country, as being of particular importance in this respect.

It is obviously a truism, that whereas British factories are not addicted to the employment of large machines, they are within their limits nevertheless very flexible. On the other hand, we are not very flexible in the bigger ranges of products. There seems room in both countries for a middle road.

[Photo by courtesy of Interscience Publishers, Inc

The Work of W. H. Carothers

By Vivian Stannett,
A.R.I.C.

Ten years ago Dr. W. H. Carothers died. As a mark of appreciation of the work of this great American organic chemist, which has affected our industry so greatly, we have asked Mr. Stannett, chief chemist of Utilex, Ltd., who has long been one of his admirers, to compile the following notes.

WILLIAM HUME CAROTHERS died in 1937, at the early age of forty-one. From 1928 until his death, he worked as head of the organic chemistry section of the research station of E. I. du Pont de Nemours and Co., at Wilmington, Delaware. During those nine years, he made a number of outstanding contributions to the theory of organic chemistry, and developed the basis for several new materials of considerable commercial importance. Two of these materials, neoprene and nylon, have since become completely familiar to the world public, although the name of Carothers remains unknown. The full extent of Carothers' work in high polymers is also comparatively unknown to many technical workers, even to those directly concerned with large molecules, as in plastics.

Besides the actual contributions to our knowledge of high polymers, a study of Carothers' work becomes valuable as it reveals the splendid technique of his experimental work and his methods of handling the new types of product he obtained. His way of working is seen to be thorough, methodical, and characterized by acute powers of observation and a simplicity of outlook.

The whole work of Carothers falls roughly into five groups:—

(1) General contributions to the theory of high polymers.

(2) Detailed study of the condensation type of polymer.

(3) Detailed examination of the addition type of polymer, derived from acetylene compounds.

(4) Study of the formation of large many-membered ring compounds, such as synthetic perfumes.

(5) Some miscellaneous general work, mainly carried out before 1928.

Only the first three groups will be considered here, as they are more directly concerned with the plastics industry. It is important to remember, however, that

Carothers' work ranged over such a large field, and that he tackled other problems than high polymers with some success. Also, it was on the results of his early and now little-remembered work that his reputation, leading to his responsible appointment with Duponts, rested.

Theory of High Polymer Chemistry

Carothers was one of the first workers to attempt to introduce order into the chaos which was high polymer chemistry. Although these conclusions are now comparatively ancient history, this paper is worthy of study, not only for the value of its subject-matter, but also to serve as a model of a precise and clear-thinking examination of the subject, prior to embarking on an investigation. The value of this is undoubtedly proved by the great successes which followed. The key to this success is not least the simplicity and the capacity to see the problem as a whole and in the right perspective.

In his first paper on this subject, he set about clearing the ground for the series of important papers which were to follow. In this, he pointed out that the term "polymer" itself had never been adequately defined. Berzelius had recognized "polymers" as compounds having the same atoms in the same proportion, but of different molecular weights. More recently, other well-known workers had also adhered to the view that a polymer and its monomer must have the same atoms in the same proportion. Carothers pointed out that certain substances, universally accepted as polymers, did not satisfy this condition, and gave us one example, the polyoxymethylenes, which, although considered polymers of formaldehyde, do not contain the same proportion of atoms.

By an examination of those polymers, whose formulæ were known, he arrived at some interesting and important conclusions. He found that they were all characterized by the presence of a recurring structural unit, the number of which units could be very small, such as three in the case of paracetaldehyde, or very large, as in the polyoxymethylenes. In general, the units were not capable of an independent existence.

From a further study of the known structures of polymers, Carothers distinguished two main types. First, there were those polymers in which the recurring structural unit is identical with the monomer, as in the case of polystyrene and rubber. The second type are seen to have the molecular formula of the structural unit differing from the monomer by one molecule of water. An example of this type are the polyethylene glycols.

The first type of polymer can be transformed to monomers by simply heating, and the monomers are polymerized either spontaneously or by the action of catalysts. With the second type, degradation to the monomer is brought about by the addition of water or hydrolysis and polymerization by the elimination of water among a large number of molecules. Carothers called the first type "addition" or "A" polymers, and the second type "condensation" or "C" polymers. Polymerization is then seen to be the chemical union of many similar molecules, either "A" without, or "C" with, the elimination of simple molecules, such as water, ammonia, or hydrochloric acid, etc. Carothers, a few years later, defined polymerization very simply as the chemical combination of a number of similar molecules to form a single molecule. A polymer would then be any compound, formed in this way, or degraded by the reverse process.

It was also in his first paper on high polymers that Carothers introduced the term "functionality." A "functional" group in the monomer is simply an arrangement of atoms, which can lead to a reaction step, simple examples being the hydroxy and amino groups. A monomer is termed mono-functional, if it contains one such group, per molecule, bi-functional if it contains two, and so on. Examples of bi-functional compounds are glycine and lactic acid, or more generally, hydroxy acids and amino acids. Intermolecular condensation of

hydroxy acids would lead to polyesters, and of amino acids to polyamides.

The conception of functionality was developed considerably further by a paper read by Carothers at a meeting on polymerization, held by the Faraday Society in London in 1936. In this paper he developed a simple general formula, connecting the extent of a condensation polymerization with the "degree of functionality," that is, the number of functional groups per molecule. He also gave an interesting example of the application of his formula to the well-known glycerol-phthalic anhydride condensation reaction.

Condensation Polymers and Nylon

Carothers set about a systematic study in the laboratory, of polycondensation reactions. He selected glycols and simple dibasic acids for his first subject, and found that when the formation of five and six membered rings was possible, these were largely formed. On choosing materials, which precluded the possibility of this type of ring formation, he found that polymers were formed. From theoretical considerations and from their molecular weights and other physical properties, he concluded that the polymers formed were linear polyesters, and not ring compounds. A great many polyesters were prepared, and their properties determined. The molecular weight of these esters varied between about 2,000 and 5,000.

A big step forward in the work was made after about two years, by the use of the molecular still. A new form of this type of still was designed by Carothers, and his associates, for the work. This instrument, which permits the vaporization of all but high molecular weight substances, enabled the elimination of the water, formed by the condensation reaction, to be carried out more completely. Consequently, polyesters of much greater molecular weights were prepared. These would have been impossible to make, using ordinary vacuum distillation, and without the molecular still, Carothers' search for super polymers might well have failed. The new polymers were obtained by heating the normal polyesters for up to 12 days in the molecular still; polymers up to 10,000-25,000 molecular weight were thus obtained. He gave the name "super polymers" to those materials with a molecular weight greater than 10,000.

The super polyesters were found to be tough solids, melting to viscous liquids at high temperatures. It was discovered that threads could be drawn from the molten polymer with a rod. These threads were examined, and found to have the property, that when cold, they could be drawn out to several times their original length. Furthermore, it was discovered, that the cold-drawn fibres had different properties from the original ones. They had greater lustre and transparency, and a much greater tensile strength and elasticity. Fibres were also made by dissolving the polymers in chloroform, and spinning in a similar way to cellulose acetate rayon. These fibres could also be cold drawn with similar results.

These discoveries were considered to be of such importance as to justify switching the whole investigation from the fundamental to the more practical end of discovering a commercially valuable synthetic fibre. The super polyesters, however, were found to have too great a solubility and too low melting points for use in textiles. Nevertheless, it was reported by one enterprising American journalist that Dr. Carothers had predicted the manufacture of women's stockings from anti-freeze and castor oil! A linear polyamide had previously been prepared, and what was apparently a super polyamide was then made from it using the molecular still technique. This, however, was found to be too insoluble and infusible to be spun. Mixed polyesters and polyamides were then made in an attempt to make a compound with the advantages of each type. This, too, was unsuccessful, as the super polymers thus prepared were again too soluble and with too low a melting point to be of commercial value.

After a careful examination of his past

work, Carothers then decided that he would resume work on the polyamides. This proved to be a very wise decision, and super polyamides were made by molecular still treatment which could be spun and yet had a strength when cold drawn equal to silk. Melting point and solubility characteristics were also suitable. This encouraging result led to a large number of super polyamides being prepared from many amino acids and also from many dibasic acids and diamines. Finally, on February 28, 1935, an important date in high polymer history, the super polyamide from hexamethylene diamine and adipic acid was prepared. This could be spun from the melt, and the fibres when cold-drawn were of high tensile strength and melted at a temperature as high as 263 degrees C. The polymer was also insoluble in all common organic solvents. This compound was selected for commercial manufacture because it had the best balance of properties and manufacturing costs. It is usually known as the 66 polymer, to the fact that there are six carbon atoms in the diamine and six in the dibasic acid.

Work was then started for developing the commercial manufacture of the two raw materials, of the polymer, and of the fibres. In less than five years Dupont chemists and engineers successfully transformed the laboratory discoveries of Carothers to the well-known nylon yarn. Carothers continued his search for new polyamides, but his results only confirmed the wisdom of the choice of the 66 polymer, and the same is true to-day, although a great many new kinds of polyamides have since been prepared.

Addition Polymers and Neoprene

It should first be mentioned that the deliberate point of these investigations was to produce a synthetic rubber which would be in certain properties superior to the natural products, Duponts having decided that a market existed for such a material, even if it were more expensive than natural rubber. In this series of successful investigations Carothers started with two highly reactive compounds, vinyl acetylene and divinyl acetylene. The discovery that these two compounds could be prepared by passing acetylene through aqueous cuprous chloride solution was made by Nieuwland and his co-workers at Notre Dame University in 1925. This method was commercially practicable and gave Carothers a good starting point for his work. An extensive study of the reactions of these two materials was carried out and led to some valuable and interesting results.

One of the most important of these discoveries was that aqueous hydrochloric acid reacted with vinyl acetylene in the presence of cuprous and ammonium chlorides to yield a compound which Carothers named "chloroprene," by analogy with isoprene, which it closely resembles in structure. Further, he discovered that chloroprene, a colourless liquid of low boiling point, rapidly and spontaneously polymerizes to a rubber-like solid. This polymer was found to be distinctly superior to natural rubber in some of its properties. Here, then, was the basis for the synthetic rubber which they were seeking.

This, of course, was only the beginning; the polymer was not capable of being worked on a mill to a smooth sheet and behaved more like a vulcanized rubber. However, Carothers found by careful investigation that the polymerization could be stopped at a stage when a soft polymer was formed. This was a more plastic body, and could be milled, compounded, extruded, etc., very much like raw natural rubber. It could later be changed to the "vulcanized" form by heating until polymerization was complete. This process was found to be much speeded by the addition of accelerators; on the other hand, materials having a definite inhibiting effect were discovered. These enabled the storing of the polymer in its plastic condition. The new rubber was also obtained as a latex by emulsion polymerization. An interesting point which was noted was that,

unlike other synthetic rubbers, the X-ray diagram of the fully polymerized material showed a crystalline structure when stretched just as did natural rubber.

Naturally, the developing of such a material for the commercial market involved the solution of a great many problems, but "neoprene," as it was named, was finally marketed successfully in 1931 and was the first synthetic rubber to be produced commercially. Since then many improvements have taken place and a whole range of standard "neoprenes" are now available; it is still unequalled for many purposes, such as contact with oil and petrol, and for solvent resistance.

The results of the work on neoprene were published in a long and interesting paper in 1931.

Over the next three years, a series of papers followed, in which a great number of related topics were expertly dealt with. These included an important series of investigations into the effect of substituents on the rate and degree of polymerization of butadiene-type systems. Extensive work was also done on the polymerization of the vinyl acetylenes, and on their general chemical reactions, such as the formation of addition compounds. Homologues of chloroprene were also fully discussed and investigated.

Finally, an example of the breadth of imagination of Carothers can be given. He had noticed the phenomenon that when a tube of chloroprene vapour was irradiated, polymerization started as a solid speck and then proceeded to grow on its own into a "cauliflower-like mass" until all the monomer was exhausted. Similarly, if a granule of this polymer is placed in a fresh supply of monomer, this will also grow until all the monomer is used up. The "life" of these granules persists for about seven days. In two papers Carothers called attention to the curious analogy of this process to that of "vital growth," and suggested it as a field worthy of further study. Although the mechanism of this type of polymerization is now more fully understood, it is a tribute to his imagination that he could think of an observation made in the laboratory in this philosophic way, and to his courage that he should publish his thoughts with such emphasis.

General References

Collected Papers of W. H. Carothers, Vol. 1, High Polymers (N.Y.).

Bolton, Development of Nylon, Ind. Eng. Chem., 1942, **34,** 53.

GERMAN INDUSTRY REPORTS

With reference to the publication by the British Intelligence Objectives Sub-Committee of Reports on German Industry, and in connection with the Exhibition on this subject which is now touring certain regional centres, the Board of Trade points out that although no invention made in Germany during the period between September 3, 1938, and December 31, 1945, can become the subject of a valid British patent, it is still possible that some of the information gathered in Germany may be covered by valid patents in the United Kingdom.

To avoid infringing patent rights firms interested in exploiting any particular item are, therefore, advised to investigate the patents position in the United Kingdom before going into production. Similar investigations are also desirable before exports are made to any particular country abroad.

PLASTICS AT LYONS FAIR

On this occasion of the Annual Fair at Lyons there will be a special section devoted to plastics. On Saturday, April 19, there will be a "Plastics Day," to be held in the Amphitheatre of the Faculté des Sciences, Quai Claude Bernard, under the auspices of the Institut de Chimie Appliquée and various plastic manufacturing companies in Lyons. Among the latter are Alais, Froges at Camargue; Alstom; Kuhlmann; La Collonge; Manufactare Lyonnaise de Caontchonc; Rhodiaceta; Rhone-Poulenc; Resines et Vernis Artificiels; St. Gobain, etc. During the morning, conferences on recent advances will be held, while the afternoon will be reserved for visits to the stands.

The Fair opens on April 12 and closes on April 21. Further particulars are obtainable from Clifford Martin, Ltd., Piccadilly House, Regent Street, S.W.1.

G

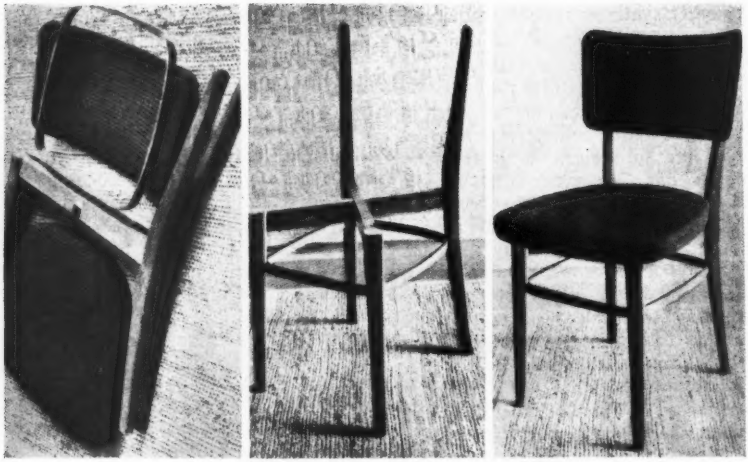


Fig. 1.—There are five "ready-made" parts for this Swedish dining chair. (The parcel when it arrives is complete with screws for assembly.)

Plastics for Furniture

By G. FEJÉR

I FEEL that the reader's first reaction to this title will be "What! chairs, tables and beds moulded in plastics? No, thank you!" But what I really would like to examine here at some length is the relation between the new trends in furniture design and construction, and how far such trends rely on the forthcoming of plastic materials and processes.

Obviously, a close relationship exists between the latest techniques of furniture construction and plastic materials, which will have both immediate and long-term implications. I hasten to add that the immediate scope in using synthetic materials is very much limited, not only because plastics of all kinds are in short supply even for established uses, but also because time has to elapse before any new revolutionary technique in furniture construction can sufficiently justify itself, and before such trends can be taken seriously from the point of view of production.

When I am speaking of furniture, I do not mean all the multitude of various trades as they are defined officially under the heading of "furniture." According to the Ministry of Labour's classifications, and definitions laid down by the British Trade Joint Industrial Council, a great number of firms, whose activities range from "bedding" manufacture to "rugging mattress" manufacture, fall within this term. I have used the word "furniture" by thinking mainly of the *primary equipment* that converts an empty house into a home (without taking soft furnishings into consideration).

New Designs and Constructions

During the war years, quite a number of the earlier trends reached a more advanced stage and are sufficiently crystallized in detail, so that they can

now be regarded as alternatives to methods of construction which are conventional.

The established practice of making wooden furniture, consisting almost entirely of solid timber and fitted together by skilled cabinet makers, will no doubt continue, and I do not think there will be any decline in the volume in which such furniture is required by the public, but this volume is nowhere near able to satisfy current needs. Most of the new constructions are meant to replace the sort of furniture which is neither a product of craftsmanship nor particularly suited for modern methods of repetition production.

There are only very few firms in this country using modern plant, and large-scale organization (only two out of 3,000 firms employ more than 750 workers) with which to turn out mass-produced furniture* and improvements and new constructions are called for mainly to avoid a sort of semi-mass-produced article coming on the market which may, as happened before the war, combine the *disadvantages* of both handwork and modern repetition production.

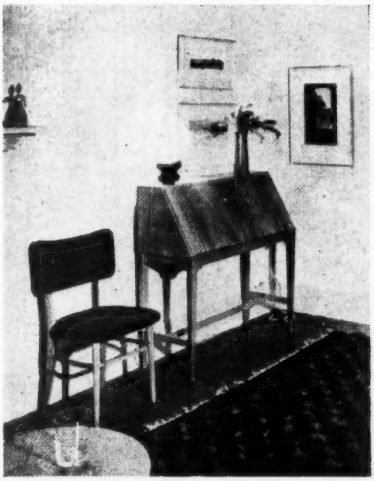


Fig. 2.—Further examples of Swedish furniture recently exhibited at the Building Centre, in London, and intended for assembly by the user.

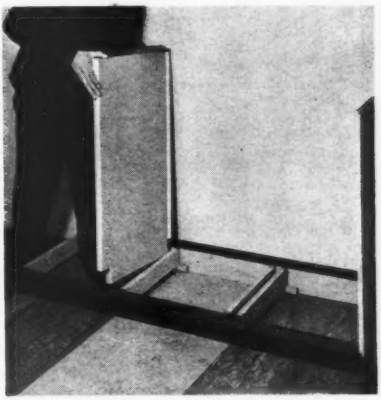


Fig. 3.—Assembly technique of "Selection" fitments is easy, because all parts are fastened with bolts and wing-nuts. An upright division panel is slotted into the base.

It will be realized that furniture is going to be the subject for study and design research for some years to come. I do not attempt to do more than to give the reader a few glimpses by way of examples, which to me, at any rate, indicate the definite lines of development.

Line-assembly Techniques

The customary method in assembling the parts of furniture is that of a selective assembly where each part is fitted to its neighbours by a skilled man, using some durable and often tricky method of fastening. The assembly techniques in engineering have gone the other way by gradually introducing the principle of *interchangeable assemblies*. That is to say, the constituent parts are turned out as repetition products manufactured to close limits, and no more subject to the individual fitting or machining to suit the assembly. During the war, the work on aircraft components has made many a wood-working or small engineering firm conscious of the importance of such

* The figures given here refer to all types of furniture; that is, they include soft furnishings.

Fig. 4.—Typical "Selection" fitment as shown at the recent "Britain Can Make It" Exhibition. All parts are standardized and interchangeable. (Designer: G. Fejér, for Selection Engineering Co. Photo by courtesy of Uni-Seco, Ltd.)

methods, and the benefits it can bring to the total job if properly handled at all levels. I think I am right in saying that to-day the manufacture of furniture has not yet reached a stage where we can talk about interchangeable assemblies being very much of an established practice, but it is also beyond doubt that the trend is strong enough to make a lasting effect on the outlook on design work and general approach.

More "Knock-down" Types

To transport furniture in the "knocked-down" stage is a trend which is also well known, and which also has increased in importance during the past few years. The mere fact that furniture, and especially cabinet work, is bulky by its very nature, and is liable to a great deal of damage in transit, has led designers to adopt techniques which lend themselves to break down the assemblies into easily packed parts.

A cabinet which can be "knocked down" and packed successfully, and which can also be easily assembled by anyone has a great deal of scope in marketing. Deliveries can be effected to a much wider range and export becomes a real possibility. This was recognized some time ago in Scandinavian countries, especially where the principal sawmills are at some distance from the consumer-centres. The tendency to carry out as much fabrication work as possible at the sawmills has led to a whole range of designs, the chief feature of which was dry assembly. The constituent parts of a cabinet are often packed in a way that they can be put together by the consumers themselves. As far as one can ascertain, developments in Denmark, Sweden and Norway have been concentrated on smaller units, such as small cabinets, tables and chairs, and bookshelves, but the real saving in space, and the real benefits of standardization, come into play if the principle is developed

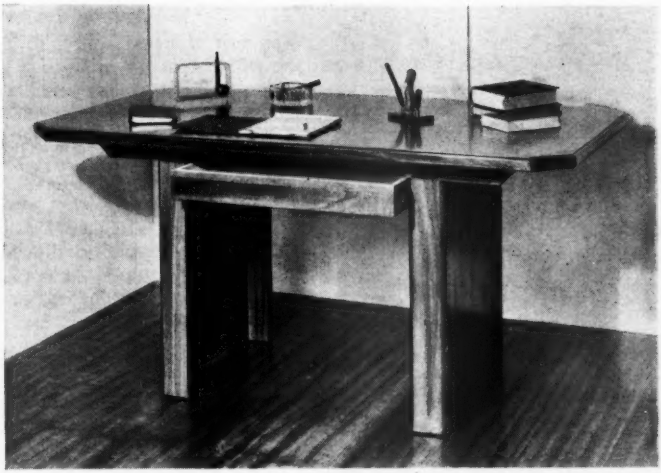


Fig. 5.—In the construction of this writing table, Compactom Ltd. have used veneered "Holoplast" boards. (Photo by courtesy of Compactom Ltd. and Holoplast Ltd.)

Fig. 6.—A further example of the use of veneered "Holoplast" board in furniture construction. (Photo by courtesy of Holoplast Ltd.)

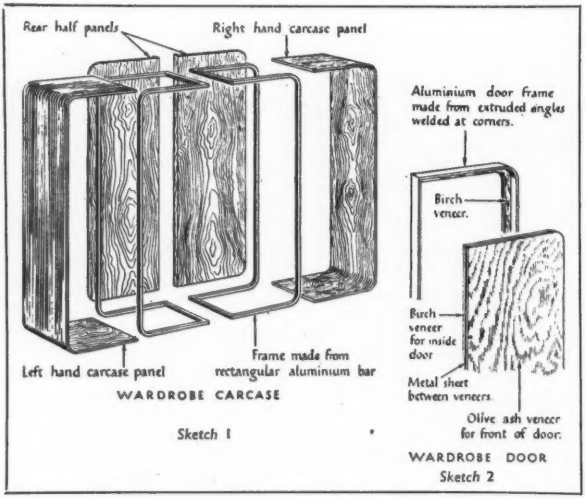

Rear half panels
Right hand carcase panel
Left hand carcase panel
Frame made from rectangular aluminium bar
WARDROBE CARCASE
Sketch 1
Aluminium door frame made from extruded angles welded at corners.
Birch veneer.
Birch veneer for inside door
Metal sheet between veneers.
Olive ash veneer for front of door.
WARDROBE DOOR
Sketch 2

Fig. 7.—Principle of construction for wardrobes and like furniture, using veneered aluminium sheets combined with extruded aluminium frame members. (Designer: C. Latymer, for Heal and Son, Ltd.)

fully for biggish items, such as built-in fitments. Successful experiments in this direction have been carried out in this country during the war, and a system will probably be put into production in the near future.

Laminated Metal Sandwiches

The actual component parts of interchangeable assembly and "knock-down" furniture must be made of materials which are capable of accurate manufacture and dimensional stability during the course of storage and transit. Solid timber in itself is not always ideal for such techniques, whilst metals have at least one virtue, and that is fair dimensional stability under varying moisture conditions.

Great efforts have been made to make fabricated metal attractive for domestic and office furniture, and this has led to developments of sandwiches, which consist of metal sheeting as well as a low-density materials core, which will prevent drumming and add a certain amount of stiffness or solidity to what might otherwise prove to be somewhat flimsy metal sheeting.

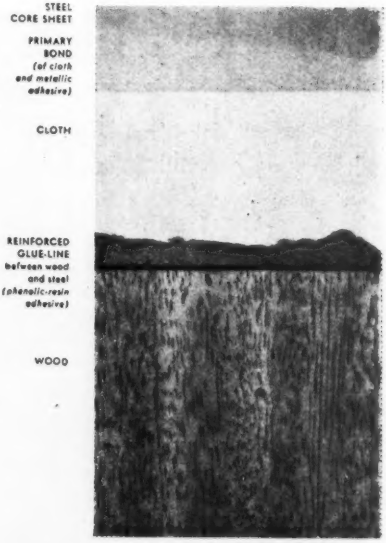

STEEL CORE SHEET
PRIMARY BOND (of cloth and metallic adhesive)
CLOTH
REINFORCED GLUE-LINE between wood and steel (phenolic-resin adhesive)
WOOD

Fig. 8.—Bonding of wood veneer to steel. This photograph illustrates the pre-war technique as used in manufacture of Robertson's bonded metal. (Photo by courtesy of United States Plywood Corporation.)

Hollow Plastic Constructions

An inspiring new material has been developed during the war in this country, which consists of paper-laminated plastic sheeting, fabricated in such a manner that it has both rigidity and fairly easy workability, and is readily applicable for the manufacture of 1-in. thick flush panels. The sheets are finished on both sides and are available in a range of typical phenolic colours, or else veneered with real wood veneers. Alternatively, the surfaces can be treated with synthetic paint, stove-enamelled on both sides.

Laminated Sandwich Boards

Successful experiments have been carried out during the past 10 years in the use of expanded plastics, faced on both sides with thin sheeting. Organic sheeting, such as plywood, wood veneer have been used, but there is no technical reason why " all-plastic " sandwich could not be produced by using one of the grades of expanded plastics as a core, and paper laminated or fabric-laminated phenolic material for the two skins. The board would lend itself admirably to the production of cabinet components, counter tops, flush doors and flush bed-heads, combining lightness with a firm and stiff construction. The difficulties arise first, in the present-day costs and, secondly, in finding a satisfactory method of assembly that would be practicable with prevailing labour conditions.

Pliable Twin Sheeting

A thin " twin sheet," consisting of one layer of metal and one layer of wood veneer, has been marketed before the war in the United States, and was described in " Plastics," August, 1942, where a photograph (here reprinted) showed the structure of the steel-cum-wood sheet. The advantage of such twin sheeting, consisting of, say, steel and wood veneer, is that the sheet can subsequently be used by engineering firms who have metal-working capacity, and the sheet can be bent to various radii. In fact, for the manufacture of radio cabinets, curvatures as narrow as 1 in. radius have been known to be successful in fabrication. The twin sheet can be welded on the steel side, yet it can be glued on the wood face, even with using ordinary wood-working glues. Further, the sheet can be assembled by the usual metalworking technique of riveting or fastening with self-tapping screws, grommet rivets (" pop rivets "), etc.

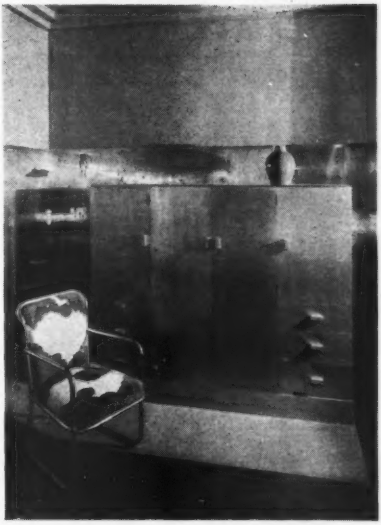


Fig. 9.—Design for cupboard carried out in Venesta " Plymax " (laminated aluminium-faced plywood). (Designer : Serge Chermayeff.)

Similar sheet, fabricated for a range of furniture that was exhibited at the " Britain Can Make It " Exhibition, consisted of aluminium (as the metal) combined with wood veneer on the faces. The bond between the two layers has been effected by using the Redux process. The technique of fabrication has been described in the Aero Research Bulletin No. 49, January, 1947. It can be seen, therefore, that the technique of using twin sheet for furniture is a trend which was coming on slowly during the past 10 years, and owing to the present shortage of timber the technique of

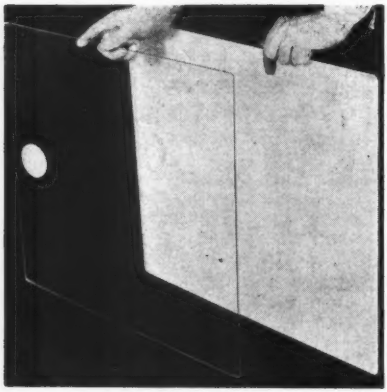


Fig. 10.—Sliding door panels for book-shelves, etc., (methyl methacrylate and paper laminate plastic) as made for "Selec-tion" fitments. (Photo by courtesy of Uni-Seco, Ltd.)

development may be accelerated. The use of the synthetic-resin bonding technique is the essential key to the success of this development.

Metal-faced Plywood

This material is not exactly new to furniture makers; in pre-war days many firms, especially those who specialized in shop-fitting, had a great deal of experience in using metal-faced plywood. The metals (which were both steel and non-ferrous alloys) are, as a rule, permanently bonded to plywood, and the edges sealed by welding or by similar specialized means. There are many examples of fitments made of these materials, but on the whole the development of the technique and applications to cabinet work was interrupted and diverted by the war.

Plastic Sheeting

Both thermoplastic and thermosetting sheeting was used occasionally in pre-war days, and rapid strides have been made recently in the use of decorative sheeting, such as laminated plastics with decorative top veneers, and the best examples are to be found in the interior decoration of ships, hotels, bars, and also in some railway carriages.

Thermoplastic sheeting, such as methyl methacrylate, has been put to a number of uses in furniture construction. Unfortunately, the pre-war American examples rather tended to exaggerate the properties of this lovely material, but apart from such ideas as transparent chairs and tables, there are many examples in which transparent and translucent sheeting has found its proper use. I should certainly recommend the replacement of glass with thermoplastic material, wherever the essential lightness and freedom from brittleness is of importance, even at the expense of reduced surface hardness. Thermoplastic transparent sliding doors for bookcases and drawers, for instance, may require slightly more cleaning and attention, but they

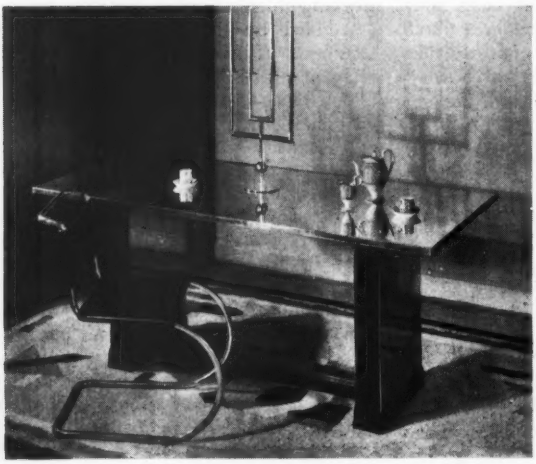
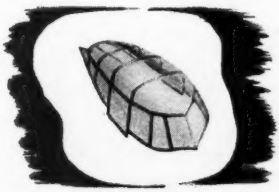


Fig. 11.—Monel metal table incorporating Venesta "Plymax." (Photo by courtesy of Heal and Son, Ltd.)

Plastics go aloft



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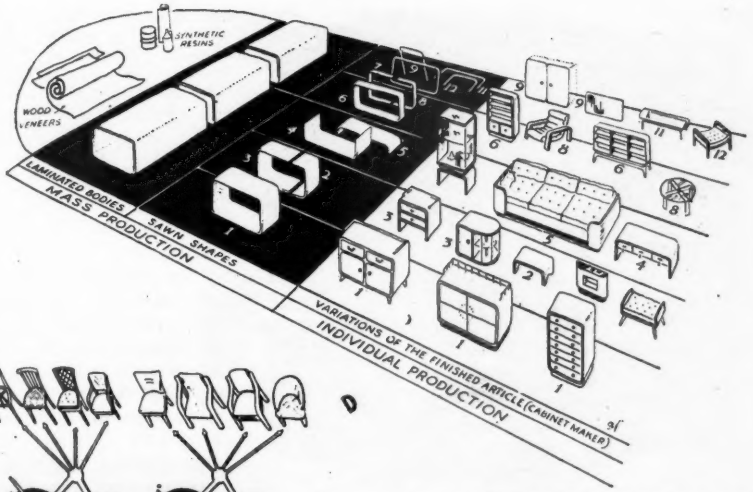


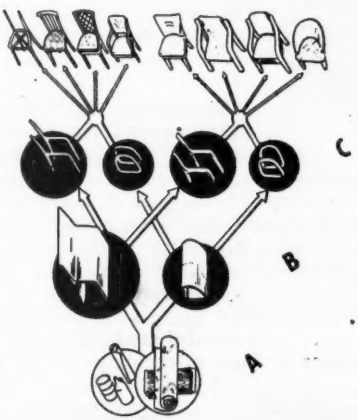


Fig. 12 (above).—Design study for use of bent laminations assuming large-scale production of standardized bends to be used by individual furniture manufacturers. (Designer: G. Fejér).

Fig. 13 (left).—Similar study for the production of chair components. A, raw material; B and C, mass produced shapes; D, individual assemblies.

are safer and lighter than solid glass sheeting for the same purpose.

Compressed sheeting, consisting of thermosetting material and wood waste products, have been used for a number of purposes, such as backs and drawer bottoms, as well as sliding panels, and there is no technical reason why the further expansion along this field should not continue.

Bent Laminations

Whilst the above trends are primarily considered in producing a flat sandwich sheet as the standard material prior to fabrication, there is ample scope for the development of *purpose made moulded bends* and shapes which would form the "raw material" for subsequent production of furniture items. Two studies on this subject are illustrated; one appeared in "Plastics," August, 1942; the second was published in the American "Modern Plastics," April, 1943. In both cases I have set out the inter-relation of moulded mass-produced shapes for large-scale production, designed in a way that the initial material is still suitable for a number of individual models to be fabricated by the conventional woodworking firms. Bearing it in mind that the furniture industry both in this country as well as abroad chiefly consists of smaller firms employing fewer than one hundred people, and using conventional woodworking tools, I felt that there is a need for mass-produced laminated components which would simplify assembly and jointing, still giving the smaller maker some individual scope.

Fig. 14.—An example of the use of "Perspex" for moulded drawers in shop fitting. (By courtesy of "Architectural Forum," December, 1946.)

can be obtained on a given part (in order to reduce heavy tools costs on the manufacturing run). I feel that as soon as a system of construction is sufficiently standardized to take interchangeable drawers and trays, the moulding of these items becomes practicable.

Apart from these items, examples are known where entire cabinets were composed of plastic mouldings, that is to say, the doors, panels and counter-tops have been carried out in compression-moulded plastics.

Moulded Components

Moulded items such as handles are, of course, in use, but the application of integrally moulded larger components in furniture construction is bound to make headway. For instance, I suggest the use of cornerless drawers which can be carried out either in resin-impregnated fabric mouldings, or else using a sheet suitable for post-forming. The only criterion where to use integrally moulded parts is governed by the question of quantities, and the degree of repetition that

Extruded Plastics

Nearly all laminated products have the common weakness of exposing vulnerable

Fig. 15. — Extruded "Rockite" beading, as supplied by F. A. Hughes and Co., Ltd., for the construction of desks. (Photo by courtesy of Roneo, Ltd.)

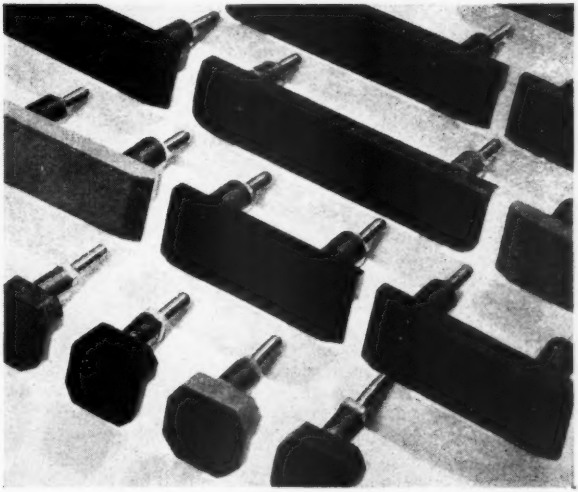


Fig. 16.—A range of furniture handles, made by Regal Plastics Ltd., using extruded "Rockite" sections supplied by F. A. Hughes and Co., Ltd.

edges, which also tell the story of how the laminated sheet has been built up. It is not always possible for the designers to hide such edges, and this is where the judicious use of extruded plastics might be extremely valuable. Compared with metal extrusions, the warmer feel of thermoplastic materials may be of advantage, but, of course, the cost and availability make this type of moulding rather difficult for the present moment. The number of stock moulds available now, even on the American market, for instance, seems to be nowhere comparable with the choice of metal mouldings developed for a similar range of use.

New Materials Bring New Problems

The above glimpses into the possibilities of using new materials for furniture construction are not intended to create impression that all difficulties can be overcome by using some extraordinary material which is as yet unfamiliar to cabinet makers. The industry, at the present moment, is struggling with problems connected with old materials used in conventional designs. Some of the difficulties, no doubt, can be overcome by new designs using still conventional methods, or else the other way round, incorporating into traditional designs some material not yet generally known.

It is obvious that developments both on the design, method of fabrication and the material side have gone on, and the really post-war furniture, once the present emergency is over, will be very different from the 1938-39 standard. This can be clearly visualized if we compare the developments that have taken place between 1930 and the immediate pre-war period; but this time the intervening eight years have given even larger impetus to the technical facilities. On the consumer side the continuity has been broken, and the new, less biased strata of consumers are to be considered, who are probably more flexible in their outlook on furniture and probably less insistent in their demands for mechanical embellishments.

Do not let us forget, however, that new *techniques*, new *materials* and the new *public* are all as yet untried, and design, manufacture, and marketing (closely linked together in development work) present many unknown factors. No individual firm can be expected to achieve miracles and incorporate *all* the innovations in their forthcoming products. Some will stick to pre-war designs and experiment with revolutionary techniques, others will still call on their own customary facilities and production technique,

evolving cautiously articles that are more up to date in their appearance only.

The immediate scope for the plastics industry to help with the production of furniture is very much limited by the above considerations. It will be realized, however, that synthetic adhesives have come to stay with the majority of the firms who have had experience with them during the war years. Furthermore, it is also safe to assume that nearly all laminated and fabricated "sandwich" products will use considerable quantities of synthetic adhesives or synthetic material with high resin content.

With regard to accessories, such as knobs and handles, plastic mouldings are now almost universally accepted. A certain amount of plastic sheeting will be used cautiously for table tops and counter tops of various kinds.

With regard to finishes, cellulose as well as synthetic resins for spray finishes will continue to gain ground, now helped by the knowledge and experience gained in quick-drying methods that were employed on war jobs.

To combine the smooth "press finish" of plastic sheeting with plywood or hard board is quite a real possibility. Experimentally, one can use, for instance, wood veneers that are first treated with thermosetting resins and will set under heat and pressure. The plastic in such cases acts both as the finishing, waterproofing and bonding agent. The texture of the press platens will govern the "gloss" of the surface.

The evolution of a new type of furniture for home use and export is going to be the subject of long-term planning if the recommendations of the Furniture Working Party (appointed by the Board of Trade) are going to be adopted. It is beyond doubt that there is an urgent need for co-ordinated research that goes beyond the narrow limits of a single company or even a single industry. On the other hand, the development of new types of furniture calls for the daring policy and pioneering spirit which is often found among smaller firms, and does not always come forth where large committees are at work and all interests are duly considered.

It is clear, in my opinion, that whilst technical information on markets, techniques and materials must be available on the broadest possible scale, the individual freedom of action for both furniture and plastics firms will be maintained, and there will be ample scope for development at all levels. When the present stop-gap period is over, and the new approach to furniture construction comes into its own, we shall see many sensible new designs which are more than slight improvements on the 1938-39 range.

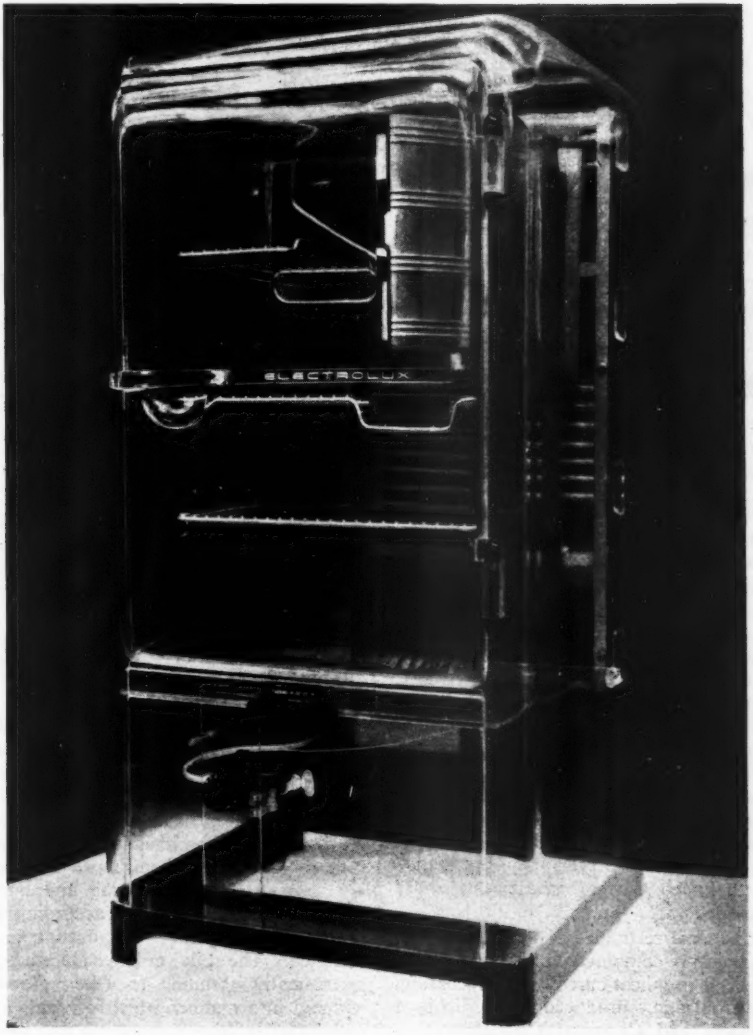
Chemical Society Centenary

The programme of the Centenary Celebrations of the Chemical Society, July 15-17, 1947, which, but for the war, would have taken place in 1941, is marked by a number of events emphasizing the position of chemistry in Britain to-day. The Society was the first of its kind in the world.

By means of a dinner to be given by the University of London and a reception by the Royal Society to the Chemical Society and the 11th International Congress of Pure and Applied Chemistry, the academic world and the senior scientific society of Great Britain will contribute to the occasion. The Royal Institution will give a party to distinguished visitors from overseas on July 17.

It is expected that distinguished guests will be present at the centenary dinner. The scientific events of the programme include the Faraday lecture, to be delivered by Sir Robert Robinson, president of the Royal Society; lectures of historical nature, and visits to places of scientific interest in the London area. An exhibition in the Science Museum, South Kensington, which will be open to the public until the end of September, will illustrate the achievements of British chemistry during the past 100 years, and its importance to the every-day life of the community.

At the Society's luncheon on March 20, Professor C. N. Hinshelwood, the president, said that £18,000 had already been subscribed to the centenary appeal, which it is hoped to devote to a fund to bring eminent foreign scientists to this country to address the members.



This demonstration refrigerator has been made in transparent "Perspex" for Electrolux, Ltd., who are showing it at the "Daily Mail" Ideal Home Exhibition in London. The object of the transparent plastic is two-fold: it permits an explanation of the refrigeration process to be conveniently followed by the eye, and also facilitates a demonstration of desirable positions for various foodstuffs inside the cabinet according to the best low-temperature storage practice. Plastic fabrication by Thermo-Plastics, Ltd., Dunstable.

World's Industry Employs Plastics

GENERAL ENGINEERING

Undue wear of machine tools because of inaccuracy of the guiding ways has been eliminated by a new non-metallic table way developed by G. A. Gray Co. The bearing surfaces of the ways consist of laminated plastics produced by Formica Insulation Co., using fabric impregnated with phenolic resins. ("Scientific American," 1947/Feb./78.)

Mechanical properties of mouldings manufactured from thermosetting materials are affected when submitted to free atmospheric conditions under mechanical load. The implications of this are discussed in Schweizer Archiv, translated in "Engineers' Digest," (1947/Feb./61). Various tests were made relating to the effect of conditions of environment on the mechanical properties. Bending tests are reported for phenol-asbestos, phenol-wood flour, phenol-fabric and urea-cellulose. Regarding the modulus of elasticity, the loaded test bars showed more scatter than those unloaded.

Chemical resistance of newer synthetic coatings are combined with advantages of rubber in heat-cured rack coating, Miccroplastic, produced by Michigan Chrome and Chemical Co., Detroit 7. The non-inflammable coating is said to offer complete protection for racks in all metal-finishing operations. ("Products Finishing," 1947/**11**/120.)

Fatigue tests with Duralumin $\frac{1}{16}$ in. thick, cemented with various adhesives, such as "Cycleweld" and "Redux," showed that the samples broke in the material itself and not in the bonded portion. Fifteen specimens tested under alternating loads up to 5 million cycles showed that, in all cases except one, the metal itself fractured. ("Modern Machine Shop," 1947/**19**/212.)

Chemical engineering uses of plastics are discussed by A. E. Williams, who states that their special advantage, compared with glass and fused silica as non-metallic materials, is that of easy machinability. ("Practical Engineering," 1947/**15**/72.)

Wire and cable manufacture is utilizing synthetics in replacement of rubber, according to a paper which H. B. Slade presented at Wire Association Annual Convention, Oct., 1946. ("Wire and Wire Products," 1947/**22**/43.)

TEXTILES

Treating pile fabrics with cellulose-ether finish "Coglin" and a rubber latex backing composition is claimed to render them more resistant to ageing and laundering, according to Sylvania Industrial Corporation of America. The pile of the material is permanently bound to the ground material in a manner which prevents the withdrawal of the fibres. Pile fabric of any type may be treated, preferably by back-filling, with the compound of Coglin and rubber latex conjointly coagulated upon the fabric and forming a continuous permanent coating, binding the pile tufts and individual fibres to the ground threads.

Vinylite resin, Teflex, for use as textile plasticizer, has been developed by H. V. Walker Co., New Jersey. The product is adaptable to any woven fabric and may be used in coating leather or any smooth-finish flexible material. It may be applied by dipping, roller-coating, knife-coating or spraying, and shows minimum tendency to "string" or "cobweb." (Reuters Trade Service.)

Textile fibres made from "elastic nylon" have properties approaching those of rubber. The elastic properties of this new material have been investigated by R. C. Houtz and W. W. Watkins (Abstract of paper before American Chemical Society in "Product Engineering," 1947/Feb./132).

MOTORS

Plastic laminated panels, for use in the motorcar industry, are not only decorative, but show little signs of wear or scratching, compared with the traditional materials. The laminates used in this work are high-strength paper laminated to a core of heavy phenolic resin-impregnated alpha cellulose paper, two methods being used for processing this sandwich structure; one is a hot-forming method, the second is similar to that used for moulded laminates. The sandwich is placed in the laminating press and cured; it is then cooled so that it cannot warp. All operations on the inside station-wagon panelling and on the garnish moulding are being carried out in the plastics laboratory of the Briggs plant. ("Scientific American," 1947/Feb./66.)

Equipment in plastics department of Ford Motor Co., at River Rouge, is given in "Auto. and Aviation Industries" (1947/96/18, 82); this department handles about 360 different parts, i.e., 80 per cent. of Ford plastics.

MISCELLANEOUS

Absorption of infra-red and ultra-violet rays, with transmission of visible light only, is claimed for new plastic material, Infropake. This material is available in several colours and transmits approximately 84 per cent. visible light with practically no ultra-violet transmission. Uses include sports goggles, automobile windshields, and sun visors. Food-packaging foil made of thin Infropake will be available for use on items normally damaged by exposure to ultra-violet and infra-red radiation. ("Scientific American," 1947/Feb./89.)

Injection - moulding processes for Mycalex, a ceramic - like glass - mica plastic, are described in "Scientific American" (1947/Feb./85). Micalex can be moulded into great variety of shapes, such as rotating equipment, heating devices, motor parts, welding equipment, etc.

Conveyor-type table for use in handling plastic materials is being marketed by Island Equipment Corporation, New York ("Modern Machine Shop," 1947/Jan./329). The table has three control handwheels; one is used for quickly adjusting height, the other two provide convenient operating positions for the belt travel. The equipment can be supplied with variable-speed units, 300 r.p.m. maximum.

Mar-proof serving tray, with individual food wells, each separated and insulated, has been produced by a New Jersey firm. Sharp cutlery, abrasive cleaners, and hot or cold water have no damaging effects; moreover, the tray will not stain or retain food odours. (Reuters Trade Service.)

Musical instruments are latest application of shatter-resistant transparent Plexiglas. Rohm and Hass announce that a

set of instruments, ranging from a grand piano to clarinets, has been made, and that they possess the advantage of being unaffected by weather changes. (Reuters Trade Service.)

Synthetic clothes-line, manufactured from a derivative of Koroseal, recently introduced on a small scale, is now showing heavy demand, according to B. F. Goodrich Co.

Synthetic insulation can be stripped from fine copper leads by new process, which V. Canziani describes (" Machinist," 1947 / **90** / 1763). The coverings are softened by a two-step chemical process, whereby the fine-wire copper leads are left in prime condition for soldering at 600 degrees F.; this is said to overcome breaks in tinning and assembly.

Electrical requirements for Nesa coatings on windshields of laminated glass with vinyl plastic interlayer are discussed. (" Auto. and Aviation Industries," 1947/ **96**/154.)

Plastic signs for buildings, requiring no repainting or polishing, and which may be cleaned by wiping with a damp cloth, are being produced by the Wintres Stamp Manufacturing Co., Elizabeth, N.J.

Transparent acrylic plastics may be sawn with same power equipment as that used for metal and wood, but special circular, band and jig saws ensure maximum production and finish. " Machinist " (1946/**90**/1671) discusses saw selection, as regards thickness, kerf and teeth. Water-oil cooling should not be used to cut mask sheet unless the masking is to be removed after sawing.

Inexpensive method for cutting polystyrene, acrylics, and other thermoplastic materials so that no subsequent sanding is necessary to obtain a highly polished surface in one operation, has been developed by Howard H. McNash, 576, South Falmouth Drive, Cleveland, 16 Ohio. Transparent slit cuts can be made into polished parts, and gates neatly removed in one operation. The method is applied to an electric saw.

Injection moulding of thermoplastics is described in " Machinery " (Lond.) (1947/**70**/198). Thermoplastic materials become viscous on the application of heat, and on cooling the original properties are restored. Little waste results from the moulding process and the materials commonly used are enumerated. Various equipment is described.

Silicone rubber has possibilities for components in which heat resistance, flexibility in tension, and dimensional stability under compression, are required. Illustrated article by E. M. Irish and J. R. Stirrat (" Product Engineering," 1947/**18**/ 146) gives physical and chemical properties of four silicone rubbers of General Electric types 12600 to 12603, and discusses their applications.

New packaging plastic, in general applied by spraying, consists of modified film-forming vinyl resins carried in volatile solvents (Cocoon of Coatings Division, R. M. Hollingshead Corporation, Camden, N.J.). Complete machines can be protected in this way, and stripped when desired. The material does not adhere to metal surfaces, pads, or other areas. (" Modern Machine Shop," 1947/ Feb./316.)

SOURCES OF REFERENCE.

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

New Style Storage for Records

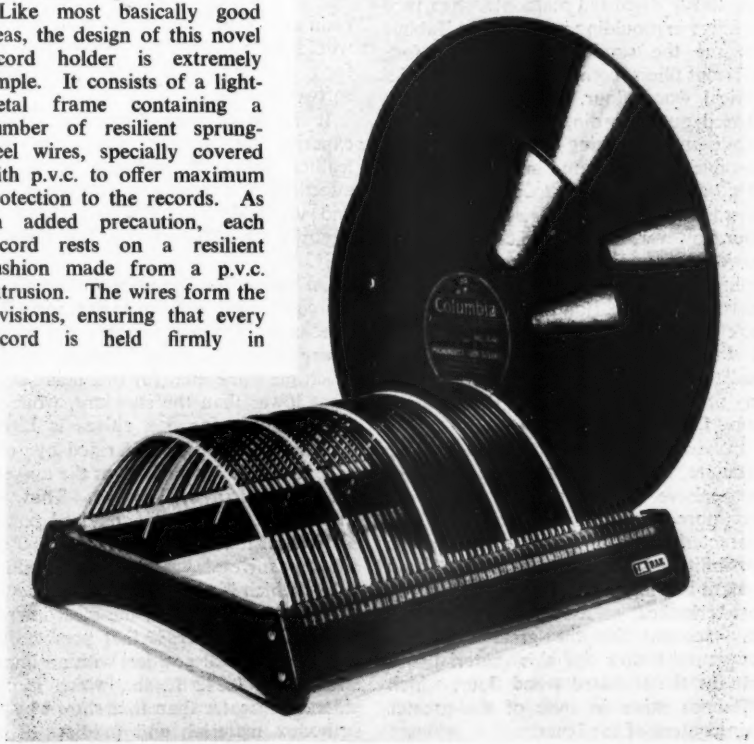
MOST of us are always intrigued by ingenious ideas, and the simpler they are, the more pleasing. We were, therefore, delighted to receive from Mr. Geoffrey Imhof, the managing director of the famous musical-instrument house, Alfred Imhof, Ltd., of New Oxford Street, London, an example of their latest production.

Many attempts have been made to solve the problem of really compact gramophone-record storage. Few have been so successful as the new lightweight portable IM/RAK, which holds up to 50 10-in. and 12-in. records, yet requires little more space than a medium-sized table lamp.

Like most basically good ideas, the design of this novel record holder is extremely simple. It consists of a light-metal frame containing a number of resilient sprung-steel wires, specially covered with p.v.c. to offer maximum protection to the records. As an added precaution, each record rests on a resilient cushion made from a p.v.c. extrusion. The wires form the divisions, ensuring that every record is held firmly in position, yet is instantly accessible; each division being numbered for indexing.

For owners of a very large number of records, new units can be added, as with a unit bookcase. For this reason, there is a wide range of gay, modern colours to choose from, enabling records to be grouped and quickly identified. Although designed to be easily transportable, this new-style record library can be adapted as a permanent fitting.

The rack is designed and manufactured by Alfred Imhof, Ltd., the p.v.c. extrusions being supplied by Tenaplas, Ltd., Upper Basildon, near Pangbourne, Berks.



The Microscopic Examination of Plastic Materials

VI.—Mouldings (Fillers)—(f) Fibrous Materials

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

Having examined the characteristics of fillers produced from natural products which yield so-called powder products, the author now turns our attention to similar materials produced from natural products of a fibrous nature.

BY way of finalizing the conclusions and observations already made, let us examine some of the results produced by previously discussed materials when used as fillers in moulding powders. In Table 1 we see the results produced by four different fillers, compared with those of a typical wood flour. All the tests were carried out according to B.S.S. 771, the conditions of mixing being as nearly as possible kept the same in each case. In this way it was hoped to produce results which would bear comparison. It will be seen, however, that the typical wood-flour powder contains 50 per cent. resin, as against 33 per cent. for the experimental powders, and, bearing this in mind, let us look at the results produced. For the flow test, these results show that coconut-shell powder gives an easier flow than any of the others, including the standard wood flour.

In view of the difference in particle structure, this (in part) is to be expected, as we have seen that the shell powder was more consistent with regard to this characteristic than the others; also, the possibility of the higher available lignin content helping in this direction must not be overlooked, as it is possible that this may account for the great difference between the flow for this material and that for the standard wood flour, which difference exists in spite of the greater resin content of the latter.

The other experimental powders, with the exception, perhaps, of the beech-wood flour, show flow figures commensurate with their resin content and the nature of the filler. In the case of the beech filler, however, it is highly probable that the improvement in flow is due to the filler, and in a powder containing 50 per cent. resin and 50 per cent. beech flour the flow would be considerably lower than that for a similar powder made with standard softwood flour.

It should be pointed out here that the experimental sample made up with leather flour was included by way of affording a comparison between animal and vegetable products, and should be regarded as of interest in this direction only.

On examining the impact strength, we are confronted with an interesting set of conditions, for we see that the impact strengths for the wood flours are all very much the same, that for oak being somewhat lower than the standard, while the figure shown for flax shives is higher. This will, perhaps, be clarified by reference to Table 2, which gives the averages for the figures in Table 1. Thus, the impact strength for the standard powder is 0.141 ft./lb., while that for oak is 0.115. The flax shives, however, show a figure of 0.148, which is not unexpected in view of the nature of the filler; the most interesting result, however, is that produced by the coconut-shell powder, with an impact strength of 0.242 ft./lb., which is considerably greater than that shown by the orthodox material, and in view of the

Table 1

	Beech flour (33% resin)		Oak flour (33% resin)		Flax shive (33% resin)		Leather flour (33% resin)		Coconut-shell flour (33% resin)		Wood flour (50% resin)	
Flow (seconds) ..	10		17		19		15		8		12–15	
Impact strength ..	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area
	0.125	0.196	0.090	0.195	0.150	0.191	0.060	0.205	0.245	0.192	0.125	0.191
	0.140	0.193	0.110	0.194	0.145	0.196	0.050	0.200	0.215	0.191	0.135	0.190
	0.145	0.189	0.120	0.196	0.150	0.197	0.060	0.199	0.260	0.194	0.150	0.184
	0.145	0.193	0.130	0.194	0.140	0.199	0.050	0.204	0.230	0.192	0.145	0.185
	0.140	0.197	0.155	0.191	0.155	0.199	0.059	0.197	0.260	0.193	0.150	0.189
Tensile strength (p.s.i.)	8,524 8,280 7,060		9,333 8,215 9,541		7,581 6,760 7,580		1,560 1,568 1,551		9,423 9,173 9,541		7,520 5,991 6,411	
Plastic yield (millimetres 90°C.)	1.0 3.5		2.0 2.0		2.5 3.5		3.0 10.0		2.0 2.5		2.0 2.5	
Water absorption (milligrams/specimen)	106 98		136 120		320 300		275 275		93 97		72 69	
Swelling (in inches)	0.002 0.001		0.0015 0.0015		0.0015 0.0005		0.005 0.008		0.001 0.0015		0.001 0.001	
Electric strength (kv.)	20	18	17	19	19	10	20	20	20	17	15	14
(seconds) ..	15	10	50	10	20	5	inst.	15	5	16	50	10
(volts/mil.) ..	147.0	136.6	131.7	142.8	145.0	143.8	148.1	153.8	137	131	115	107
Surface resistivity (megohms)	24,871 17,923		30,254 37,792		10,110 8,217		30,444 42,956		22,508 16,664		46,095 57,297	

Table 2.—Average of Figures in Table 1.

	Beech flour		Oak flour		Flax shive		Leather flour		Coconut-shell flour		Wood flour	
Flow (seconds) ..	10		17		19		15		8		12–15	
Impact strength ..	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area	Ft./lb.	Area
	0.139	0.194	0.115	0.194	0.148	0.196	0.054	0.201	0.242	0.192	0.141	0.188
Tensile strength (p.s.i.)	7,955		9,030		7,307		1,596		9,379		6,641	
Plastic yield (millimetres 90°C.)	2.25		2.0		3.0		6.5		2.25		2.25	
Water absorption (milligrams/specimen)	102		128		310		275		95		70.5	
Swelling (in inches)	0.0015		0.0015		0.001		0.0065		0.00125		0.001	
Electric strength (kv.)	19		18		14.5		20		18.5		14.5	
(seconds) ..	12.5		30		12.5		15		10.5		30	
(volts/mil.) ..	141.8		137.25		144.4		150.95		134		111	
Surface resistivity (megohms)	21,397		34,123		9,163		36,700		19,586		51,696	

difference in resin content it is all the more remarkable, more particularly as the general particle shape of the coconut-shell flour would lead one to expect a lower impact strength. Here, again, it is highly probable that this is due, in the main, to available lignin, which takes part in the final resin reaction.

The leather filler shows poor impact strength, and, in fact, this material is poor in general, due chiefly to the degeneration of the filler as a result of the heat encountered in the moulding operation, and in view of this it is proposed to ignore this material in further discussion of these results.

Turning to the plastic yields, we see that they are much the same, and here again we must not overlook the significance of the difference between the resin contents of the experimental samples and the control which would lead one to expect somewhat better figures from the former if the resin contents were equal.

The moisture absorption for the experimental samples are somewhat varied, and in view of the fact that for these materials the resin contents are the same, this variation would appear to be due to the characteristic differences inherent in the filling materials used. Thus, for the wood flours, beech shows the lowest moisture absorption and flax shive the highest; the effect of a higher resin content is well shown by the figure for the control, which is the lowest of them all.

The coconut-shell-filled material is again seen to be superior, and it is highly probable that, if the control had been made up with 33 per cent. resin, the figure for the moisture absorption of the coconut-shell filler would be the lowest.

With regard to the swelling, there is only a slight variation between the materials under discussion, which is not unexpected.

The figures for the electrical characteristics are interesting and open the way for much speculation. For example, the breakdown figures (kV./mil.) show that, of the experimental samples, the oak filler is the lowest, although it will be seen that the figure for the control is even lower. However, in view of the previous deductions regarding the effect of the higher lignin content encountered in the hard woods, this is not altogether unexpected; the surprise, however, appears in the figure for the coconut shell, for which one would expect a much higher figure because of the high lignin content.

During the examination of coconut-shell flour, it was suggested that the lignin was present in the histological elements of the shell in two forms, viz., that portion which, in all probability, was laid down as an integral with the original cellulose wall of the cells (and as such considered to be in combination with the cellulose), and the other portion, consisting of lignin, which was added to the original thickness of the wall. It is this latterly added lignin which it was suggested was available as reactive material in the filler, and it was further suggested that, as there were reactive phenolic groups present, it would be desirable to so adjust the formaldehyde content of the resin that full use may be made of these groups in the final curing.

In the powder under consideration, no such adjustment was made, and it is highly probable that, in the finally cured condition, there is an appreciable percentage of such phenolic groups which are uncombined. As the presence of such groups would have a very adverse effect on the electrical characteristics of the moulding, a low breakdown figure is rather to be expected than otherwise, presuming the foregoing suggestions to be the true state of affairs existing in the material. In view of the evidence in support of this given by the other figures, and the lack of definite evidence to the contrary, we are justified in adopting this hypothesis until such time as it is proved to be unfounded. Thus, in this way, it is possible to explain the existence of this anomalous result.

Much the same condition is demonstrated by the figures for surface resistivity, but the effect of the high resin content in the control is shown with great clarity.

In summing-up these results, it may be concluded that the coconut-shell filler is, in general, somewhat more efficient than the others, although it would appear that there is considerable scope for improvement in the use and manufacture of these materials, so that even better results may be obtained from the same materials. It will be seen also that the results support, in the main, the conclusions arrived at during the study of these materials under the microscope and, in general, justify the assumptions made, which may, therefore,

be taken as the basis of a working hypothesis regarding the functions of the filler in a moulding composition.

Continuing our examination of filling materials, let us now turn our attention to the possibilities offered by the more highly fibrous portions of plants in general. As can be imagined, the majority of the fibres of commerce are obtained from the monocot plants, the reason for this being that they consist, in the main, of the phloem bundles from the vascular units of the stem and leaves and, owing to their great length and strength, they constitute valuable raw materials.

The effect of a fibrous filler in general upon a moulding material is well known, for it produces greater physical strength in all directions without impairing the electrical characteristics. The most widely used material for this purpose is cotton flock, and as we have already discussed the attributes and drawbacks of the cotton fibre under the section dealing with laminates, it is not proposed to discuss this material in any great detail.

There is, however, a material very similar in nature to cotton which is extensively used as a filler for urea-formaldehyde mouldings, in the form of sulphite wood pulp. There are several interesting points in this material which merit discussion in some detail, and it is, therefore, proposed to examine this in the usual manner.

This material is the result of the usual treatment of softwood indulged in by the paper-pulp manufacturers. As the process involves the breaking down of the wood into its individual tracheids, from which the lignin is extracted and after which the resultant cellulosic material is beaten in a pulp beater, it will be readily appreciated that the tubular nature of the original tracheid undergoes a considerable risk of being greatly altered so far as its morphology is concerned. That this is so is very well shown in Fig. 168, which is a photomicrograph of some sulphite woodpulp at a magnification of 45 diameters, and from which it will be seen that elements which were originally

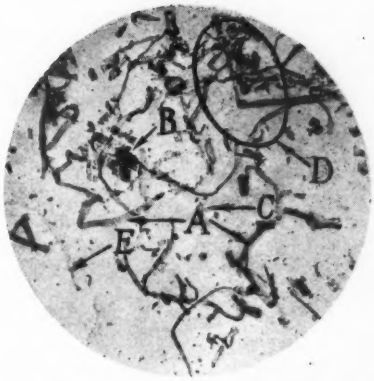


Fig. 168.—Sulphite woodpulp: general nature of material. Mag. 45 diameters.

tubular tracheids now bear no resemblance to their original shape. Thus, at A we see elements which are typical of the material and exhibit a tape-like form; these are representative of the larger elements of the material. In addition to these, there appears to be an appreciable quantity of smaller elements, such as the agglomerate at B, and the very small pieces at C.

A feature of this material is the manner in which the elements tend to agglomerate into groups, such as that shown at D, while in other cases the elements appear to remain separate. This would appear to be comparable to the felting of wool fibres, but as in this case the elements are smooth and have no scales, which help the felting of wool, it is probable that, in the case of the sulphite woodpulp, the agglomeration is due to electrical forces developed in the handling of the material. The presence of soluble material in this pulp is indicated by the line marked E, which will be discussed in detail subsequently.

The agglomeration appears to take place by two methods, the one consisting of a number of small particles agglomerated round a large element, and the other consisting of a few large elements forming a tangled mass; a typical

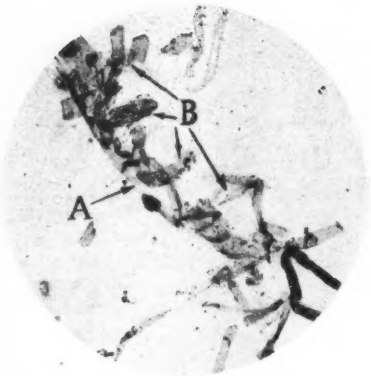


Fig. 169.—Sulphite wood pulp: typical agglomerates consisting of small particles. Mag. 110 diameters.

Fig. 170.—Sulphite wood pulp: agglomerate shown as tangled mass of long elements. Mag. 110 diameters.

agglomerate of the former type is shown in Fig. 169 at a magnification of 110 diameters. Apart from showing the structure of the agglomerate, this photomicrograph also illustrates more clearly the nature of the filler elements. Thus, at A we see a long, tape-like element around which are gathered a number of smaller and shorter elements, such as those shown at B, from which it will be seen that they appear to curl themselves around the long element. The numbers of small bits of elements are also worthy of note, as they would appear to function as extraneous.

As distinct from this structure, Fig. 170 shows an agglomerate consisting of a tangled mass of long elements, such as the one shown at A, although shorter elements, such as B, are also included, but in general the whole structure of this agglomerate is differently constituted from that of the previously examined one.

The nature of this material is such as to make for good properties as a filling medium, but it must be borne in mind that, as the elements are virtually softwood tracheids which have been "delignified" and subjected to disruptive mechanical forces, all we have left of the original element is the thin cellulose wall, in consequence of which the pulp element has only a fraction of the strength of the original tracheid. Thus, the pulp element, as such, may be compared to a cotton hair, so far as the chemical composition of the fibre is concerned, and also to some extent its morphology, but here the likeness ends, for the cotton fibre is an element which is used more or less in its natural state. The cellulose wall is thicker and the tubular nature of the fibre gives it added strength, thus making it very much stronger than the pulp element, size for size. In the latter, of course, the wall is thinner, and it is highly probable that the treatment has resulted in some degeneration of the cellulose, thus further reducing the strength of the element.

Morphologically, the element is good, provided that its L.B. ratio can be kept high throughout the material, but as it is this is subject to considerable variation, resulting in quite an appreciable proportion of extraneous dust, which cannot be a great deal of use owing to the thin cellulose wall; in fact, these dust particles may be regarded as being similar to the "flaky" elements arising from the thin-walled parenchyma cells encountered in the cereal-cob residue flour.

The general nature of this pulp

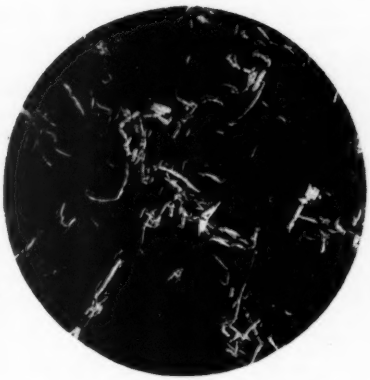


Fig. 171.—Sulphite wood pulp, under polarized light, system crossed. Mag. 34 diameters.

Fig. 172.—Crystalline deposit in sulphite wood pulp, under polarized light. Mag. 100 diameters.

material is very clearly shown in Fig. 171, which is a photomicrograph taken under polarized light, at a magnification of 34 diameters. Owing to the thinness of the cellulose wall, it is very transparent and the fine extraneous particles are difficult to show by means of transmitted light, but they become more visible under polarized light, and the illustration gives a better idea of the proportions of this material in the flour. At the same time, the tendency for the powder to agglomerate is clearly shown, likewise the variety of lengths existing among the elements.

We see that this material, although promising advantages by virtue of its particle shape, suffers from disadvantages which limit its usefulness, these being the low strength and the tendency to form agglomerates. This latter would appear to be somewhat serious, as it would offer considerable resistance to thorough mixing. The difficulty of impregnating the agglomerates with the resin will be appreciated. This, of course, would result in a moulding powder which was not uniform, producing a moulding containing numerous agglomerates of dry, or nearly dry, filler, thus resulting in a serious degeneration of both physical and electrical properties, as compared with a moulding where these did not exist.

In spite of these disadvantages, however, this material is used in fair quantities for U.F. mouldings, because of its colour, which is best described as being very white, and as the mixing is carried out with the resin in either liquid form or in solution, the difficulties due to agglomeration are considerably reduced, more particularly if the liquids possess low surface tensions. For example, the powder itself may be seen to consist of masses of very tiny agglomerates; if a small quantity of the material is placed in water, these agglomerates cannot be broken down completely, but if some powder is placed in alcohol, the agglomerates separate spontaneously, thus demonstrating that a low surface tension is essential if thorough mixing and impregnation of the filler is to be successfully achieved. At the same time, it should be borne in mind that agglomeration might also be due to electrical forces coming into play, due to disassociation in the liquid, and, taken on the whole, there would seem to be a number of factors contributing to this condition which would need to be taken into account.

When considering Fig. 168, attention

Fig. 173.—Crystalline deposit in sulphite wood pulp, under polarized light. Mag. 420 diameters.

was drawn to the line marked E in this illustration. This area is a crystalline deposit which resulted after the water, with which the specimen was transferred to the slide, had evaporated. The process adopted was to wash a small quantity of the powder in some diluted water and then centrifuge it, discarding the supernatant fluid. A small quantity of the wet powder was then transferred to a perfectly clean slide, together with a drop of fresh distilled water, so that it may be evenly spread out; the slide was then put aside in a dust-free atmosphere until quite dry, when the specimen was mounted in polystyrene. The crystalline deposit remained after the evaporation of the water.

Although by transmitted light this substance does not exhibit very marked crystalline characteristics, when examined by polarized light they are seen to be minute crystals, as shown in Fig. 172, where their presence is clearly demonstrated under polarized light at 100 diameters. These crystals would appear to be of inorganic origin, no doubt developing from remnants of the sulphite liquors present in the pulp powder, and it would appear that this was present in appreciable quantity; however, definite information regarding this is not yet available, as a detailed analysis of the sample under consideration has not yet been completed.

The crystals seen in the portion marked (A) (Fig. 172) are shown at higher magnification in Fig. 173; here, photographed under similar conditions of illumination at a magnification of 420 diameters, they are shown to be pentagonal crystals of minute size. The effect which the presence of this inorganic matter (if such it be) must have on the properties of the ultimate moulding has been taken into consideration in using this material. If it is the remnants of the sulphite liquors, as seems highly likely, then it is obvious that the electrical and, to some extent, the physical properties of the mouldings will be affected; therefore, it would seem that, by paying attention to this point, some improvement may be brought about in so far as this is concerned.

In general, the sulphite-pulp powder seems to be unsuitable for use in phenolic mouldings, due to its lack of strength and variability; thus, in analyzing it in a similar manner to that applied to the wood flours, we are enabled to subdivide it into at least four substances possessing L.B. ratios of 40 to 1, 20 to 1, 8 to 1, and 2 to 1. The variability index in each case is almost exactly 1.5 to 1, but that for the whole material is approximately 25; thus, it would appear that much is left to be desired in this respect, but this is in all probability due to the fact that, presumably, no screening was carried out upon the powder. This would, of course, account in large measure for the variability of this material.

It would, perhaps, be as well to point out that in sulphite woodpulp we have a material obtained by the chemical loosening of the structure of the wood, followed by disintegration by mechanical means. Now, it was suggested earlier that if wood flour could be produced on an economic scale by a masceration process, it might be capable of producing

(Continued on page 224.)

MONSANTO CHEMICALS

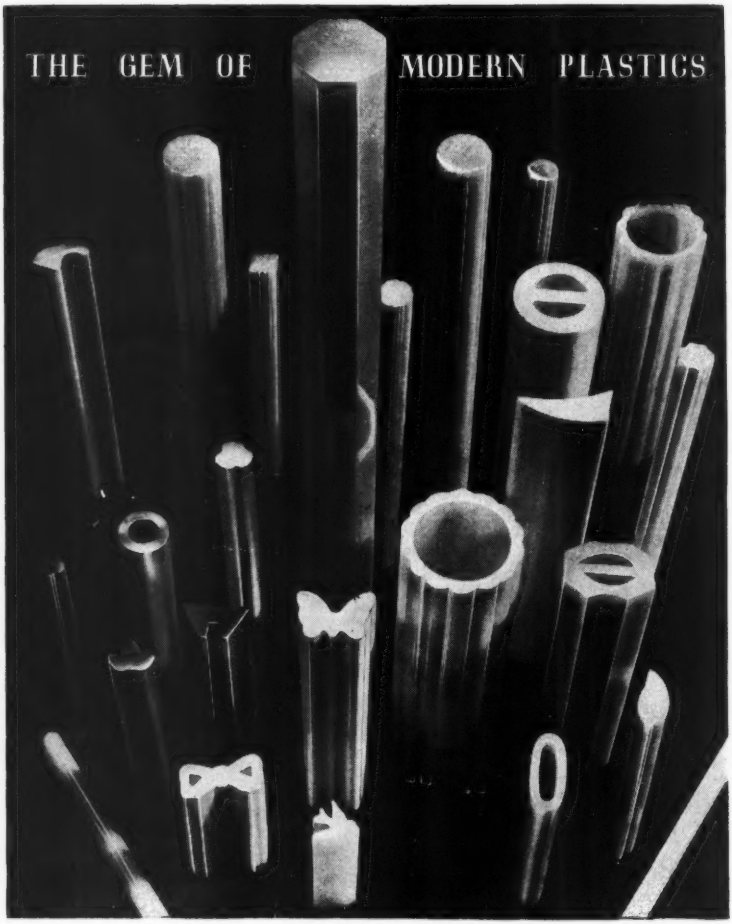
FOR THE PLASTICS INDUSTRY

PHENOL* . . . CRESYLIC ACIDS . . . PHTHALIC ANHYDRIDE* (flake) . . . DIETHYL PHTHALATE . . . DIMETHYL PHTHALATE . . . DIBUTYL PHTHALATE . . . AROCLORS (chlorinated diphenyls) . . . SANTOLITES (speciality resins) . . . SANTICIZERS (speciality plasticisers) . . . FIBESTOS (cellulose acetate) . . . BENZOIC ACID . . . SALICYLIC ACID.

* In Great Britain Monsanto are, by far, the largest manufacturers of phenol and the only manufacturers of phthalic anhydride to produce phthalate esters from their own, closely controlled, raw material.

Unfortunately many of the above products are temporarily in short supply. In the meantime, however, we welcome your enquiries and will be glad to give you full information on present and future availability.

MONSANTO CHEMICALS LIMITED • LONDON • SW1



TELEPHONE WALTHAM CROSS 3344

Catalin
TRADE MARK REGD

LTD. (Dept. P)
WALTHAM ABBEY, ESSEX, ENGLAND

Catalin is a thermosetting cast synthetic resin plastic, available in a wide range of glorious colours and mottles — opaque, translucent and transparent. It is supplied in the form of rods, sheets, cylinders, and special profile sections and is freeworking, easily machined, with good physical and electrical properties; odourless, tasteless, non-inflammable and resistant to alcohol and most acids.
Catalin's technical staff are available for consultation on any production problem.
Your enquiries are cordially invited. 9

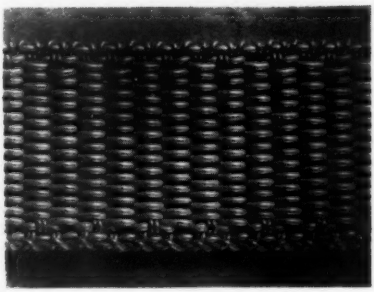
LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired.

Woven P.V.C.

Sir,—In your January issue (page 21) we note with interest a letter from J.H.T., Ltd., concerning p.v.c. threads. In your reply you state that you do not know of any concern in this country making or weaving p.v.c. threads.

We are essentially weavers of elastic fabrics, webbings and tapes and have the biggest output of any firm in this trade in the world. During the war, due to the shortage of rubber, our research department developed an elastic p.v.c. thread, which we successfully wove into elastic webbings. We now have a subsidiary company, Elastic Cloths, Ltd., extruding



rigid and elastic p.v.c. on a commercial scale in various shapes for belts, tapes, flanged strips, threads, etc.

We have discovered that it is very difficult to weave p.v.c. threads on ordinary shuttle looms, owing to the certain extensibility of the threads, which makes it difficult to keep good edges and even width. Fortunately, we are also loom builders and make the "Clutsom Shuttless" loom on which we can weave p.v.c. threads with marked success. We enclose samples for your inspection. To prevent unravelling of the threads when cutting the woven belting into strips, we find that a hot knife both cuts and seals in one operation.

So far the woven products have been exported, and that is why you have not seen any on this market. Fancy woven wrist-watch straps, however, will be exhibited by a firm in the wrist-watch trade at the B.I.F.

CLUTSOM AND KEMP, LTD.

Highfields,
Coalville.

Plastics Tools

Sir,—I would like to know where I can get small tools like punches, dies, drills, files, etc., as required for plastics craft.

Recently a book has been published, by name "Plastics Craft," which gives particulars about the equipment required.

I shall feel obliged if you will let me know two or three addresses of dealers of such tools in Birmingham and London.

S. K. SANE.

12, Chase Road,
Brownhills, Staffs.

Casting Waxes

Sir,—I am interested in the lost wax process for the precision casting of steel. At the moment, the material used for the expendable patterns is a paraffin-base wax compounded with carnauba, ceresin, resin, etc., and having a melting point of approximately 50-60 degrees C. This is injected into dies under pressure, the patterns then being assembled on to a wax runner into casting formation by heating a spatula and welding the two together.

It is felt that if a stronger pattern material could be found, definite technical advantages would accrue to the process as a whole. Polystyrene patterns have been suggested and made in America, but, I believe, have been abandoned owing to warpage and other weaknesses. I should be pleased to hear if you have any alternative suggestions. The main properties the material must possess are:—(a) Burn from the moulds, leaving no ash or residue; (b) low shrinkage when it solidifies; (c) low thermal expansion; (d) have an

injection temperature between 60 degrees and 120 degrees C.; (e) be easily welded on to a runner of the same material.

Filton Park, D. F. B. TEDDS.
Bristol, 7.

[EDITOR'S NOTE.—The production of the ideal casting wax is most difficult, mainly because of the high coefficients of expansions of many plastics. "Improved" waxes have been made with ethyl cellulose and polythene in small proportions. Astor, Boisselier and Lawrence and Co., and Rex Campbell and Co., are interested in such types.]

Diamond Scratches

Sir,—In the March issue of "Plastics" (page 118), appeared two interesting photomicrographs of diamond scratches, one showing a scratch on glass, the other a scratch on "Transpex." I have no doubt that these are actual scratches made by a diamond point, but one should be extremely careful in drawing conclusions. Thus, the diamond scratch on glass is probably made with a blunt edge with some considerable pressure. It is possible to produce with fine diamond edges, and with a limited amount of pressure, a cut on glass similar to that shown on "Transpex." It would have been of advantage if the magnification used for these photomicrographs had been stated.

London, N.W.3. P.G.

Back Issues of "Plastics"

Sir,—In consequence of the German occupation, we had no contact with your country during the last war. Although the war is over, we experience daily what the war has meant for an institute like ours, as we are not in the possession of your publication, "Plastics," as issued during the war. Constantly in the plastics literature there is reference to articles in "Plastics." Therefore we apply to you with a request to assist us in this matter.

We should appreciate it very much if it would be possible for you to send us the issues of "Plastics" up to and including October, 1946. If so, difficulties would be overcome. Should this not be possible, we would appreciate your giving publicity to this letter in the hope that some of your subscribers, or one of the large manufacturers who had more than one subscription, might be willing to place one copy of each issue at our disposal.

H. A. FRANK,
Industrial Information Department,
The Plastic Institute T.N.O.,
Delft, Holland,
Julianalaan 134.

Electric Hand Grinders

Sir,—With reference to your letter of January 9 and further to my letter dated January 7, dealing with slush mouldings and American high-speed electric hand grinders for the free-hand carving of plastics.

The two addresses enclosed in your letter have been extremely satisfactory as regards the slush moulding process; but the hand grinders still remain an almost insurmountable problem, as Catalin, Ltd., are unable to help me.

In the event of my being unable to obtain satisfaction, you advised me to contact you again. I sincerely hope that you will be able to help me with regard to the tools as I am badly in need of hand-carving equipment.

In conclusion I would like to tender my thanks for your most invaluable and prompt advice. R. H. MADDOX.

19, Turville Road,
Handsworth, Birmingham.

Translucent Plastics

Sir,—We desire to get in touch with manufacturers of translucent plastics in sheets which may be used for our lighting fixtures for fluorescent lamps. The sheets should be rectangular, measuring 1.3 metres by 0.13 metres.

R. F. RIISE.

Norsk A/S Philips,
Oslo, Norway.

[EDITOR'S NOTE.—We suggest BX Plastics, Ltd., Hale End, London, E.; Thermo-Plastics, Ltd., Dunstable, and, we believe, Lambournes, Ltd., Birmingham, 19; Cascelloid, Ltd., Leicester; Plastilume Products, Ltd., High Wycombe, Bucks; and I.C.I., Ltd., Plastics Division, Welwyn Garden City, Herts.]

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

RESINS FOR STOVING ENAMELS.—British Industrial Plastics, Ltd., have sent us a copy of a new booklet, "Beetle Resins for Stoving Enamels and Lacquers," which has just been published by their subsidiary, The Beetle Products Co., Ltd.

Urea resins, they inform us, have come greatly into use during the war years, and Beetle urea resins are being accepted as standard for quick stoving finishes which give marproof and durable films not readily discoloured by light or heat. Beetle melamine resins are of more recent introduction, and have considerably enhanced properties, especially in respect of heat-resistance, and chemical resistance.

The production of Beetle resins at the company's Oldbury Works, however, is severely restricted by shortage of raw materials, and, to make best use of the available materials, manufacture has been concentrated on three of these resins, BE.610, BE.615 and BA.502. The demand for amino-plastic and alkyd resins is very much greater than the supply, but allocations are being made on a basis as fair as possible.

MECHANICAL COMPARATORS.—E. H. Jones (Machine Tools), Ltd., have sent us leaflets dealing with the latest developments in the Sigma vertical mechanical comparator and the Sigma mechanical hand comparator. The former instrument allows an accuracy of repetition within four millionths of an inch. It can be fitted with an internal measuring attachment, which is invaluable for the production inspection of holes from $\frac{1}{4}$ to 2 inches diameter. The mechanical hand comparator is used for the inspection of parts while they are still on the machine.

GAUGE AND TOOL MAKERS' ASSOCIATION.—With a view to furthering the promotion of cordial relationships between Great Britain and the United States, the Gauge and Tool Makers' Association has taken the opportunity of sending congratulations to Mr. L. W. Douglas upon his recent appointment as United States Ambassador to Great Britain. Simultaneously they expressed the hope that Mr. Douglas would take lunch with the officers and council of the Association.

11TH INTERNATIONAL CONGRESS of Pure and Applied Chemistry will meet in London, under the presidency of Lord Leverhulme, July 16-24, when delegates from many countries will be present. Further information may be obtained from the Hon. Organizer, 11th International Congress of Pure and Applied Chemistry, 56, Victoria Street, London, S.W.1. (Telephone: Victoria 5216.)

ANGLO-POLISH TRADE TALKS.—The Polish Trade Delegation, led by Dr. Lychowski, and a delegation of British officials have held their first meeting in London under the chairmanship of Mr. Marquand, Secretary for Overseas Trade.

OVERSEAS BUYERS FOR B.I.F.—Over 1,000 overseas buyers, representing 17 countries, have accepted invitations to the British Industries Fair, which opens simultaneously in London and Birmingham on May 5.

O. AND M. KLEEMANN, LTD., is paying an interim dividend of 120 per cent., less tax, on the £100,000 capital. This compares with an interim of 30 per cent. a year ago, which was followed by a final payment of 50 per cent., making a total of 80 per cent., less tax, for 1945-46. The dividend well exceeded the market expectations and the 2s. shares closed 10s. higher at £5 10s. The shares were introduced on the market last June and dealings were commenced at 24s.

THOMAS DE LA RUE AND CO., LTD., regret to announce the death of Mr. H. J. Fenn, the secretary of the company. Mr. P. M. Studd has now been appointed secretary.

DEAL PLASTICS FACTORY.—Although the restoration of their factory building at Deal has not yet been completed, Malleable Mouldings, Ltd., decided to commence production at the end of January in order to train a skeleton staff.

SIMMONDS AEROCESSORIES, LTD., have moved their head office to Treforest, near Pontypridd, Glamorgan, including research departments hitherto at Great West

Road, Brentford, London. The London office at 2-3, Norfolk Street, Strand, W.C.1, and regional offices are unaffected by this change.

MONSANTO CHEMICALS, LTD., announce that Brigadier N. F. Patterson has been appointed works manager, at Ruabon, in connection with the company's extensive post-war development plans. Brigadier Patterson, who is a newcomer to the Monsanto organization, studied industrial administration and psychology at University College, Hull, and the University of Berlin. When he returned to England he specialized on industrial production problems. He joined Monsanto in May, 1946.

MENTMORE MANUFACTURING CO., LTD., held its 11th ordinary general meeting in London on February 26, when Mr. A. Andrews, chairman and joint managing director, stated that production in the plastics factory had increased rapidly during the year, and trading at that factory had shown steady expansion. Final dividend of 12½ per cent., less tax, recommended for ordinary shares, making a total of 25 per cent. for the year.

EAST ANGLIA CHEMICAL CO., LTD., of Aycliffe, Co. Durham, announce the following appointments:—Technical director, Mr. H. A. R. Thurlow; general manager, Mr. D. A. Dodson; chief chemist, Dr. G. Swift; plastics division manager, Mr. R. C. Walker; paint division manager, Mr. J. A. Dexter; lacquer division manager, Mr. C. Attwood.

AERO RESEARCH, LTD., announce that their agreement with J. M. Steel and Co., Ltd., who have acted as selling agents for Aerolite and Aerodux for the past seven years, ends on April 30, 1947. On and after May 1 all orders for Aerolite and Aerodux should therefore be sent direct to Aero Research, Ltd., Hinxton Road, Duxford, Cambridge. Telephone: Sawston 187/9.

TECHNICAL PRODUCTS, LTD., distributors for Shell Chemical Co., Ltd., 112, Strand, London, W.C.2, have changed their name to Shell Chemicals, Ltd. Their address remains as hitherto.

WILD-BARFIELD ELECTRIC FURNACES, LTD.—Dr. F. W. Haywood, F.R.I.C., F.I.M., has been appointed to the board of this company as technical director. He joined the company in 1938 as chief metallurgist.

FERODO, LTD., have opened more commodius premises at Ferodo House, 10-12, Handel Street, W.C.1. Telephone: Terminus 8181. Their depot at 222, Tottenham Court Road was closed on January 31.

J. MANDLEBERG AND CO., LTD., have issued a 64-page illustrated brochure to mark the reaching of their 90th anniversary. There is reference to the activities of the company during the period of the war, when considerable readaptation of existing plant and machinery was necessary to undertake urgent contracts for the manufacture of barrage and convoy balloons, aircraft dinghies, buoyant flying suits, electrically heated clothing and other articles needed by the fighting Services.

MR. HARRY TOWERS has been elected a director of The Bushing Co., Ltd. Until the end of 1946 he was general manager of Edmundsons Electricity Corporation, Ltd., having been associated with that company since 1933.

CATALIN, LTD., announce the appointment of Mr. T. Keith Symes as sales manager, consequent upon the resignation of Mr. R. A. Mills.

MR. D. ST. A. BUTCHER, A.M.I.E.E., A.M.I.Mech.E., informs us that he has relinquished the post of manager of the electrical finishes department of Jenson and Nicholson, Ltd., of Stratford.

FORTHCOMING EVENTS

April 18. I.P.I. (Midlands). J. Butler (Streetly Mfg. Co.). "Problems encountered in the Modernization of Moulding Shop Hydraulics."

April 18. S.C.I. (Plastics Group). Chamber of Commerce Building, New Street, Birmingham, 6.30 p.m. H. P. Staudinger (Distillers Co., Ltd.), "Vinylidene Chloride and its Polymers."

April 23. I.P.I. (Southern). Polygon Hotel, Southampton. Maldwyn Jones. Subject of paper to be announced.

April 24. I.P.I. (London). Waldorf Hotel. "Injection Moulding." Speaker to be arranged.

April 25. I.P.I. (Midlands). Dance, Botanical Gardens, Edgbaston.

"The Theory of Polymerization," by H. Ronald Fleck, the first of a series of manuals for students, will be published for Temple Press Ltd., by The English Universities Press Ltd., St. Paul's House, Warwick Square, London, E.C., on April 28.

New Productions from the Moulding Shops

Dressing Table Accessories

There is a resemblance in this range of four packs and a jar cap all moulded in Beetle by The Streetly Manufacturing Co., Ltd., for Arthur Berton, Ltd., of London. The tall container is for cotton wool, and has a cap with cam-action fitting for covering the hole at the top. The coil of cotton wool inside the container is withdrawn through this hole as a continuous rope. The two flat circular containers are powder boxes and are fitted with a loose inner tray to accommodate the powder puff. The rectangular container is really a trinket box, intended to hold pins, hair grips, etc. The small cap has been designed to fit a glass container. The same design motif is used throughout.

Wheels for Model Aircraft

Designed for use on powered model aircraft, the "Aerowheel" illustrated represents an attempt to produce a highly efficient landing wheel at low cost. It consists of a plastic hub to which is fitted a moulded rubber tyre. The hub is internally shaped to ensure a positive lock on the flanged inner rim of the tyre when male and female halves are cemented together under pressure. The plastic parts weigh $\frac{5}{16}$ oz. per pair and are moulded in a 1-pair impression tool from cellulose acetate powder, using a $\frac{3}{4}$-oz. hydraulic injection moulding machine designed and constructed by International Model Aircraft, Ltd., which maintains a 40-second cycle. The tyre, $2\frac{1}{4}$ ins. diameter, is made of soft natural rubber, with a hard, fabric-bonded centre which makes it quite impossible to be forced from the hub even under the heaviest of landings. In course of being assembled, the appropriate surfaces of the two halves of the hub are coated with a cellulose adhesive, pressed in contact with the tyre and left to dry under clamps.

Salt and Pepper Shakers

We have received from Tamworth Plastics, Ltd., Alders, Tamworth, Staffs, samples of salt and pepper shakers made from polythene. Readers may remember that in the February issue, in answer to a query, we suggested providing polythene liners to cellulose acetate salt and pepper pots to avoid attack. Tamworth Plastics, Ltd., therefore, go one better in moulding the whole from this excellent material.

Chemistry and Technology of the Organic Isocyanates

By S. H. Pinner,
B.Sc., F.R.I.C.
(Research Chemist, BX Plastics, Ltd.)

Information has recently been made available concerning the development and utilization of organic isocyanates in Germany. These disclosures may be expected to initiate extensive programmes of research in this country which will transform the present situation, in which only some three or four isocyanates may be purchased at high cost in Great Britain. This review gives detailed consideration to the preparation, properties and employment of isocyanates and their analogues.

MANY an organic chemical, discovered and studied in the nineteenth-century heyday of synthetic organic chemistry and subsequently consigned to the dust-laden leaves of "Annalen" and "Berichte" have been brought back into the light of day by the perspicacity of the plastics research worker. As a result of vigorous development, it is possible to-day to cite several commercial chemicals in quantity production as plastics raw materials, which only a few years back were regarded as expensive laboratory curiosities. To some extent this is true of the isocyanates.

Isocyanates figure in the very early history of organic chemistry. It is on record that Wurtz discovered the organic amines in 1854 by hydrolysing alkyl isocyanates, which he had made by the interaction of alkyl sulphates with potassium cyanate. He had made ethyl isocyanate six years previously and had discovered the urethane and substituted urea reactions. In 1849, Hoffmann established these reactions with phenyl isocyanate. Being evil-smelling lachrymatory liquids, difficult to prepare in good yields, the development of the isocyanates was slow in spite of a recognition of their importance for the identification of organic compounds. The bifunctional analogues, di-isocyanates, were first described by Snape in 1886,[85] although it is highly doubtful that Snape succeeded in isolating the pure compounds. In more recent years, progress has been rapid and some hundreds of mono- and polyisocyanates are now known.

The di-isocyanates have been combined with dihydric alcohols to give rise to a new type of high polymeric material known as the polyurethanes,[7] and have also been incorporated with other polymers, chiefly as cross-linking agents to confer heat and water-resistance and dye affinity.

Preparation of the Isocyanates

The following methods are available for the preparation of isocyanates:—

1. Treatment of amines or amine salts,[5, 25, 34, 37, 38, 41, 51, 52, 53, 84, 91] amides,[46] amino-azo compounds,[61, 62] urethanes[57] and substituted ureas[2] with phosgene at elevated temperatures.

2. Reaction between the acid chlorides and anhydrides and sodium azide.[4, 10, 11, 13, 17, 43, 49]

3. Treatment of hydroxamic acids with acid chlorides. The hydroxamic acids are made by condensing hydroxylamine hydrochloride with the corresponding ester or anhydride.[19, 77]

4. Pyrolysis of N-carbethoxy ketimines and aldimines obtained by reacting the corresponding ketal or acetal with ethyl urethane.[18]

5. Dehydration of urethanes with phosphorus pentoxide[49] or with phosphorus pentachloride.[89]

6. Reaction between alkyl iodides and silver cyanate[12, 47] or between alkyl sulphates and potassium cyanate.

7. Oxidation of isocyanides and isothiocyanates with mercuric oxide.[74]

Leaves from a Moulder's Notebook

This is the fifth in a series of notes by the B.I.P. Development Department. B.I.P. will send a copy of previous notes on request and will welcome comments and enquiries.

Transfer Moulding—3

CONTROL OF HEAT

Improvements in cure are obtainable in transfer moulding, as compared with compression moulding, due to the increased rate of heat absorption by the particles of the material. A volume of material of small cross-section passing between heated mould parts acquires heat in two ways: firstly by conduction from the mould, and secondly by friction, the resultant of the energy input—high pressure x volume. The frictional heat is almost as much as the conducted heat. Therefore if the feeds of a mould are considerably increased in cross-sectional area in order to overcome other defects in mould design, less heat will be imparted to the material (a) by conduction, as a smaller surface area of material will come in contact with the heated gates and feeds, and (b) by friction, as less energy will be used in forcing the material through larger gates. Consequently, the material entering the mould will be further from a state of polymerization with large feeds than with small feeds.

Heat control is especially important with a rapidly curing material such as Beetle. In cases where difficulties in the transfer moulding of Beetle occur in moulds successful with phenolic material, a remedy may be found by reducing the mould temperature to 265°-275°F., accompanied, where necessary, by an increase in feed and gate size. By these means, it is sometimes possible to obtain a shorter moulding cycle with Beetle than can be achieved with other materials.

No fixed rules can be made for transfer mould temperatures using Beetle, but generally speaking (a) the mould should be at the maximum temperature consistent with good moulding; (b) feeds of large cross-section, while permitting higher mould temperatures, do not enable the cure to be shortened; (c) with a separate pot mould the temperatures of the pot should

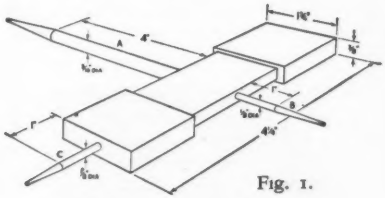


Fig. 1.

be between 180°F. and 230°F. and of the mould between 270°F. and 285°F.

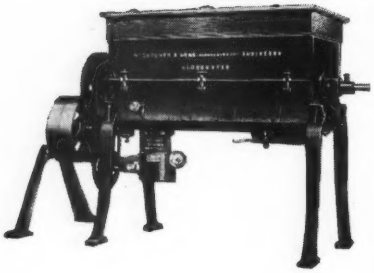
The moulding in Fig. 1 was used as a guide regarding feed positions in tests on convection and radielectric preheating. The results are charted below. Three feed positions were tried. Warping concave towards the feed was experienced with feeds A and B, together with flow or burn marks in the case of feed A. Good mouldings were produced by the use of feed C.

Feed Position	Radielectric (H.F.) Preheating			Convection Preheating		
	Flow in secs.	Cure in mins.	Remarks	Flow in secs.	Cure in mins.	Remarks
A	5	1½	Warped and flow marks	25	1½	Warped and burn marks
B	2	1	Warped	10	1½	Warped
C	2	1	Good results	10	1½	Good results

BRITISH INDUSTRIAL PLASTICS LIMITED
1, ARGYLL STREET, LONDON, W.1

A triumph in Design!

This entirely NEW GARDNER Patent DIAPHRAGMIC FEEDER & MEASURER



HAVE you a problem in which the uniform feeding of material would be an advantage?

The Patent Gardner Diaphragmic Feeder has been redesigned to reduce irregularities in the feeding of material to a minimum.

The material is fed in bulk in a "U" shaped Hopper in which a slowly revolving agitator keeps the material in a free-running state.

A control slide allows the material to enter the feeding chamber only as required to keep it full, and suitable agitators are fitted to prevent packing.

The material finally passes through the diaphragm, a principle of feeding long established by Gardners in many industries and originally patented by them many years ago.

Micrometer control of the size of opening has been introduced to ensure greater accuracy of discharge.

Many hours' supply of material can be fed in the Hopper at one charge.

Machine is equally successful for adding small or large quantities to bulk.

ALSO MODELS FOR ADDING AT MULTIPLE POINTS

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8. Action of potassium cyanate and copper on diazonium salts.

9. Action of nitrous acid on mono-substituted ureas in the presence of acid.

10. Addition to unsaturated hydrocarbons of iodo-isocyanates.[1]

Whilst all the methods cited above have been used to a greater or smaller extent, particularly in special cases, such as the manufacture of unsaturated isocyanates,[17, 18] there is little doubt that phosgenation methods are by far the most widespread and satisfactory. It is therefore desirable to consider the technicalities of the phosgenation procedure in greater detail.

The conversion of amines to isocyanates by means of phosgene is clearly a reversible heterogeneous reaction. In the case of bifunctional reactants, several steps are involved. The mechanism is probably as follows:—

Mono-isocyanates:

$$R.NH_2 + COCl_2 \rightleftharpoons R.NH.COCl + HCl \quad (1)$$

$$R.NH.COCl \rightleftharpoons R.NCO + HCl \quad (2)$$

$$R.NH.COCl + R.NH_2 \longrightarrow R.NH.CO.NH.R + HCl \quad (3)$$

Di-isocyanates:—

$$H_2N.R.NH_2 + COCl_2 \rightleftharpoons ClH.H_2N.R.NHCOCl \quad (4)$$

$$ClH.H_2N.R.NH.COCl + COCl_2 \rightleftharpoons Cl.CONH.R.NHCOCl + 2HCl \quad (5)$$

$$Cl.CONH.R.NHCOCl \rightleftharpoons OCN.R.NCO + 2HCl \quad (6)$$

$$Cl.CONH.R.NHCOCl + H_2N.R.NH_2 \rightarrow Cl.CONH.R.NH.CO.NH.R.NH_2 + HCl \quad (7)$$

It is evidently necessary to select conditions that will favour the sequence of reactions (1) and (2) in the case of mono-isocyanates and the sequence (4), (5) and (6) in the case of di-isocyanates.

It has already been stressed that the development of the isocyanates has been retarded by the difficulties inherent in their manufacture. These difficulties, apart from the stringent precautions necessary in the employment of phosgene gas, arise from the low rate of reaction and the formation of disubstituted urea or polyurea by-products.

The conversion involves the reaction between a solid and a gas, giving rise to a liquid and a gas. Salient factors concerning the rate of reaction are, therefore, the state of subdivision of the solid reactant, its solubility in the reaction mixture, the extent of agitation, and the concentration of phosgene and HCl in the reaction mixture. Modern methods for the preparation of di-isocyanates take cognizance of these factors.[5, 6, 7, 8, 33] Consideration must also be given to the elimination of conditions favouring the formation of substituted ureas, according to reactions (3) and (7). These are the presence of traces of water, HCl, impurities in the amines, metals and metallic compounds and bases. The advocacy of catalysts, such as zinc chloride and its analogues,[53] and dimethyl aniline,[36, 91] is, therefore, questionable on two counts. The applicability of other than surface catalysts in heterogeneous reaction is doubtful, and such catalysts, even when effective, may favour continuance of the reaction beyond the isocyanate stage.

On the question of the solubility and state of sub-division of the solid reactant, experience shows that amine hydrochlorides[41, 51-3, 58, 59] are definitely inferior to amine carbamyl chlorides or carbonates[5, 6, 8, 33] in solubility. A finely divided carbamyl chloride is secured by precipitating a solution of the amine at low temperatures with phosgene. Aliphatic amines are too strongly basic to be treated in this way and it is preferable to form the carbonate first by saturating the solution with carbon dioxide.

Having formed the carbamyl chloride the second stage may be accomplished by bubbling a large excess of phosgene through the reaction mixture which is at

the same time maintained under vigorous reflux. This serves several purposes. The carbamyl chloride decomposes spontaneously at reflux temperatures and refluxing combined with the passage of a large excess of phosgene promotes agitation and facilitates the removal of HCl, whilst maintaining the phosgene concentration at the saturation point. Wastage may be eliminated by recycling the effluent. It is impracticable to partially replace the phosgene by an inert gas as has been suggested.[64] While this still affords agitation, it would also reduce the phosgene concentration in the solution. For the same reason, phosgene cannot be replaced by diphosgene, despite claims to the contrary.[42]

So far as large-scale manufacture is concerned, plant should be constructed of stainless steel, chromium or pure lead, and the amines and solvents and phosgene should be of the highest possible purity. Under the most favourable conditions 75-85 per cent. yields may be obtained on the plant. Polyurea by-product may often be resaponified to the original diamine.[7]

The phosgenation procedure is unsuitable for short chain diamines inasmuch as the formation of cyclic ureas is favoured. In such cases, it is necessary to resort to the sodium azide method, which is, however, very hazardous on the commercial scale. The sodium azide method has also been used in the preparation of unsaturated isocyanates, such as vinyl isocyanate.[17] The commercial material may for this purpose advantageously be replaced by a specially activated form.[43]

Properties of the Isocyanates

Methyl and ethyl isocyanates are volatile pungent-smelling liquids. Phenyl isocyanate is a colourless liquid the vapour of which, even at normal temperatures, is irritant and lachrymatory. Cyclohexyl isocyanate and tolyl isocyanate resemble phenyl isocyanate, but are somewhat less irritant; α naphthyl isocyanate is a less mobile liquid of reduced reactivity towards water. The di-isocyanates, in spite of their reduced volatility, also have an irritant smell. All isocyanates react more or less readily with water and have to be stored in sealed containers. They generally show some physiological activity. Phenyl isocyanate has been shown to deactivate hormones.[3] It was found necessary in Germany to replace free tolylene di-isocyanates in bonding compositions by less volatile partially condensed analogues to reduce discomfort during their employment. The action of isocyanates is temporary, however, and there is no evidence as yet that these compounds are toxic.

The di-isocyanates have a tendency to polymerize when heated. Treated with alkalis, isocyanates decompose to carbon dioxide and the corresponding amine. They enter into combination with a variety of compounds, as indicated in the next section, under quite mild conditions and are therefore useful as modifying and analytical agents.

Reactions of Isocyanates

The characteristic reaction of the isocyanate group is that of addition with compounds containing reactive hydrogen atoms. The hydrogen atom migrates to the nitrogen atom of the isocyanate group and the remainder of the molecule attaches itself to the carbon atom. Thus, amines react to give substituted ureas, and alcohols to give urethanes.

Isocyanates react with amino groups about 200 times as fast as with hydroxy groups. They react with amino groups in the presence of water, but not with hydroxy groups. The sequence of reactivity is indicated (reaction 8).

Isocyanates do not react with cellulose satisfactorily, owing to the presence of water, but they do react with dry cellulose ethers.[76] Urea, bases and acid groups catalyze the reaction between isocyanates and polyhydroxy compounds.

Isocyanates also condense with Grignard compounds and diketones to give substituted amides. Direct addition also occurs between phenyl isocyanate and

$$-NH_2 > H_2O > \text{primary OH} > \text{secondary OH} > \text{tertiary OH} > \text{phenolic OH} > COOH > CONH_2 \quad (8)$$

$$PhN = C = O + H_2O \longrightarrow PhN = C\begin{matrix}OH\\OH\end{matrix} \longrightarrow PhNH.COOH \longrightarrow PhNH_2 + CO_2 \quad (9)$$

$$PhN = C = O + PhNH_2 \longrightarrow PhN = C\begin{matrix}OH\\NHPh\end{matrix} \longrightarrow PhNH.CO.NH.Ph \quad (10)$$

$$R.NCO \xrightarrow{H_2O} R.NH.COOH \xrightarrow{+RNCO} (R.NH.CO)_2O \xrightarrow{-CO_2} R.NH.CO.NHR$$
$$R.NH.COOH \xrightarrow{-CO_2} RNH_2 \xrightarrow{+RNCO} R.NH.CO.NHR$$
$$RNH_2 + R.NH.COOH \longrightarrow [R.NH.COO]^-[H_3NR]^+ \xrightarrow{-H_2O} R.NH.CO.NHR \quad (11)$$

$$OCN.(CH_2)_2.NCO \xrightarrow{H_2O} OCN.(CH_2)_2.NH.COOH \xrightarrow{-CO_2} \begin{matrix}(CH_2)_2 - NH\\ |\quad\quad |\\ NH - CO\end{matrix} \quad (12)$$
iminazole cpd.

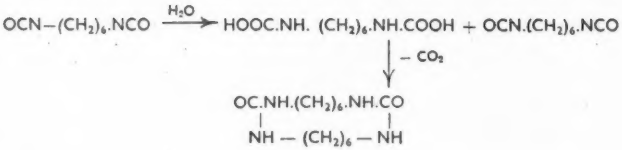
ureas, substituted ureas, thiourea, urethanes and guanidine.[75] This manifold reactivity is largely responsible for the great developments that have taken place recently in the treatment of polymeric compositions with isocyanates to increase the molecular weight or to effect cross-linking.

(1) Reaction with Water

All isocyanates react with water to give substituted ureas. In many cases the reaction is violent and instantaneous, but in others a rapid reaction occurs only if a catalyst, e.g., pyridine, is present. In this reaction, the formation of the substituted urea is accompanied by a loss of CO_2.

Lackra and Dains[75] suggest that the amine is formed intermediately and then condenses with more isocyanate to give the urea, according to reactions 9 and 10. Naegeli et al[80] have investigated this reaction in detail. They report that the reaction is influenced by the type and nature of the substituents and by the temperature of the water. Thus, cold water yields a disubstituted urea, whereas boiling water gives a greater yield of amine. They suggest the mechanism of this reaction to be as indicated above (reaction 11).

The reaction of di-isocyanates with water is particularly interesting inasmuch as cyclic compounds or polymers may result. Reaction of one mole of di-isocyanate with one of water gives rise to glyoxalane if ethylene di-isocyanate is involved (reaction 12), whereas phenylene di-isocyanate gives benziminazolone or o-phenylene urea. Similarly a di-isocyanate with three C atoms would yield a pyrimidone. According to the ideas of Baeyer and Carothers, these five- and six-membered rings are the most likely products if the di-isocyanate has two or three carbon atoms. With a greater separation between the isocyanate radicals, as in hexamethylene di-isocyanate, self-cyclization is less likely. Ring compounds may result from the union of two molecules of the di-isocyanate (reaction 13), but a step reaction leading to formation of linear polymers is more probable (reaction 14). Whether these products are, in fact, derivable has not been reported, but it is noteworthy all di-isocyanates examined



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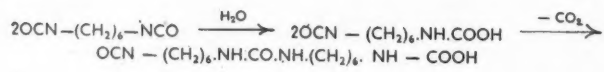

(14)

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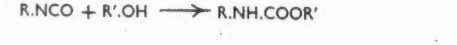


(17)

have reacted with water to give insoluble, infusible solids.

(2) Reaction with Amines

Isocyanates condense with primary and secondary amines to form substituted ureas (reaction 15). The reaction should preferably be carried out in the absence of water with phenyl isocyanate, but α naphthyl isocyanate will react with aqueous solutions of aliphatic amines, preferably in alkaline media. The effect of substituents on this reaction has been investigated, and it is reported that organic acids are catalysts.[79] With di-isocyanate and diamines linear poly-ureas may result (reaction 16).

(3) Reaction with Alcohols

Isocyanates react in a similar fashion with alcohols to give urethanes (reaction 17).

The reactants should be anhydrous. Simple alcohols react spontaneously with the lower isocyanates, secondary and tertiary alcohols react less readily. Glycols require considerable heating for both hydroxy groups to react. Phenols behave in a similar fashion, but when negative groups are present the reaction should be catalyzed by tertiary amines, such as trimethyl amine.[36]

Diisocyanates react with glycols to form polyurethanes (reaction 18).

This reaction is the basis of the production of new fibres which resemble the nylon series in properties.[7]

(4) Reaction with Grignard Reagents

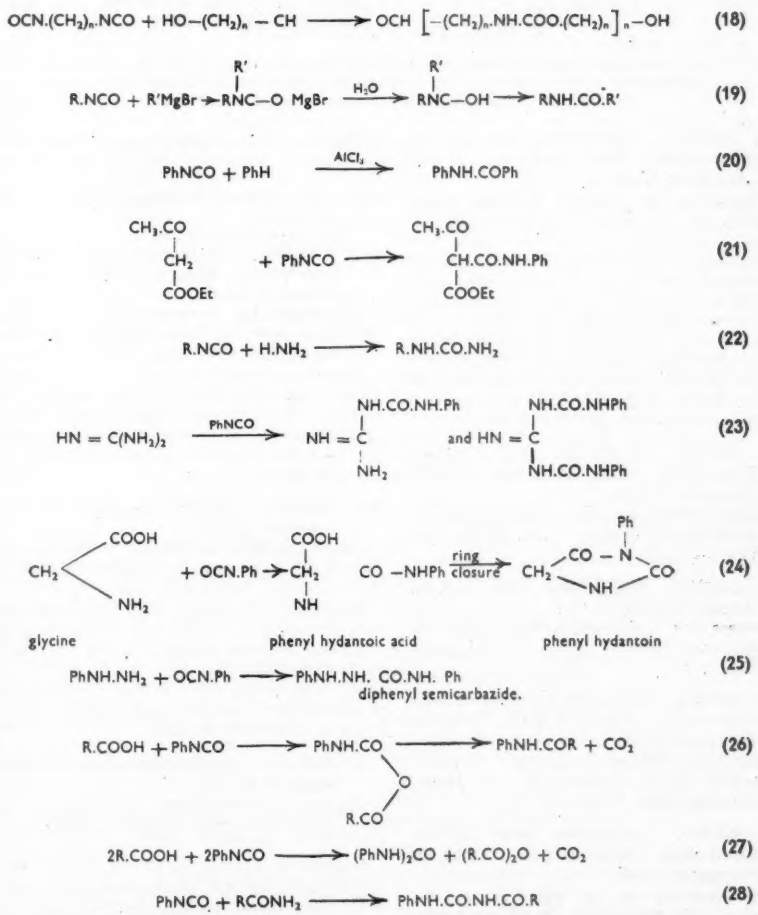
This reaction is utilized in the identification of organic halides in organic analysis, whereby the halide is first converted into a Grignard compound by treatment with magnesium (reaction 19). Since there is no free H atom in the Grignard compound, the normal Grignard addition to the carbonyl group occurs, and the product rearranges after hydrolysis to yield a substituted amide.

(5) Reaction with Aromatic Hydrocarbons

Under the influence of aluminium chlorides and like catalysts, isocyanates may add on to aromatic hydrocarbons to give amides (reaction 20).

(6) Reaction with Keto-esters and Diketones

The reactive methylene group allows migration of a hydrogen (reaction 21)



atom to the nitrogen atom of the isocyanate radical with fusion of the residues to give a C-carbanilide derivative.

(7) Reaction with Ammonia

Simple addition occurs with ammonia to give a mono-substituted urea (reaction 22).

(8) Reaction with Guanidine

Best carried out in alkaline solution, the products include mono and dicarbanilido guanidine if phenyl isocyanate is used (reaction 23).

Corresponding reactions occur with urea, thiourea, and urethane.

(9) Reaction with Amino-acids and Substituted Hydrazines

Isocyanates react with amino acids to give, amongst other things, hydantoic acid derivatives and with substituted

(Continued on page 215.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 583,874. Application date: 24.4.44. Convention date (U.S.A.): 23.4.43. Accepted: 1.1.47.

Production of Organic Fluorine Compounds. To: E. I. Du Pont de Nemours and Co.

Production of fluorine containing organic compounds by heating a saturated hydrocarbon or a non-polymerizable organic compound containing oxygen, halogene (other than fluorine), sulphur or an amino group with a polyfluoroethylene at a temperature above 50 degrees C., but below that at which decomposition would occur. Peroxides or other catalysts are employed.

B.P. 583,875. Application date: 24.4.44. Convention date (U.S.A.): 30.3.43. Accepted: 1.1.47.

Improvements in the Manufacture of Organo-Silicon Polymers. J. F. Hyde. To: Corning Glass Works.

B.P. 583,877. Application date: 2.5.44. Accepted: 1.1.47.

Process for Providing Articles made of Plastics with Painted Labels or Coverings. L. Rado.

B.P. 583,878. Application date: 2.5.44. Convention date (U.S.A.): 30.3.43. Accepted: 1.1.47.

Improved Manufacture of Organo-Siloxanes. W. H. Daudt and J. F. Hyde. To: Corning Glass Works.

B.P. 583,939. Application date: 28.7.44. Convention date (U.S.A.): 28.7.43. Accepted: 2.1.47.

Improvements in or relating to the Spinning of Filaments of Acrylonitrile Polymers. To: Imperial Chemical Industries, Ltd.

B.P. 584,015. Application date: 21.7.41. Accepted: 6.1.47.

Improved Polyvinyl Chloride Compositions. R. L. Stephens and W. O. Steel. To: Imperial Chemical Industries, Ltd.

Polyvinyl chloride compositions which can easily be cemented to themselves or other materials; these compositions contain from 1-50 per cent. polymethyl methacrylate, at least 20 per cent. polyvinyl chloride, plasticizers (dibutyl) phthalate, tricresyl phthalate, dihexyl phthalate or their mixtures) and chlorinated paraffin wax as an extender. Cementing is effected by a solution of polymethyl methacrylate in an organic solvent.

B.P. 584,116. Application date: 28.6.45. Convention date (U.S.A.): 28.6.44. Accepted: 7.1.47.

Apparatus for Severing Textile Fabrics having a Basis of Thermoplastic Material. To: British Celanese, Ltd.

Refers to apparatus for dividing thermoplastic materials into narrower widths or ribbons. It comprises a cutting blade which can be heated to a predetermined degree; the angle of this blade can be adjusted to the line of cut.

B.P. 584,140. Application date: 11.8.44. Accepted: 8.1.47.

Improvement in or relating to the Manufacture of Low Density Alginic Materials. P. H. Plesch. To: Cefoil, Ltd.

Foamed low density material produced from an alginate of low density (granulated solidified alginate foam), the foam grains being bound together by a matrix which by itself is either an alginate foam, a thermoplastic or thermosetting resin, bitumen, sealing wax, or plaster of paris.

B.P. 584,197. Application date: 4.12.44. Accepted: 9.1.47.

Decorative Articles and Materials. C. H. Hall. To: Imperial Chemical Industries, Ltd.

Decorative articles produced by mixing comminuted methyl methacrylate polymer with monomeric methyl methacrylate in order to form a kneadable mass; kneading the mass into a sheet and covering at least part of one or both of the surfaces of this sheet with a solid layer of material different in colour. This latter material is impregnated or wetted with monomeric methylmethacrylate. By superimposing a plurality of such sheets in a mould and solidifying the striated mass by polymerizing, the decorative effect is achieved.

B.P. 584,217. Application date: 15.12.44. Convention date (U.S.A.): 18.12.43. Accepted: 9.1.47.

Improvements in or relating to the Manu-

facture of Non-Fibrous Films of Water Sensitive, Organic Film-Forming Material. British Cellophane, Ltd.

Refers to regenerated cellulose films impregnated with from 30-60 per cent. of a softener (glycerine) and with an insoluble artificial resin which is capable of being formed by heating at a temperature within the range between 60-90 degrees C.

B.P. 584,284. Application date: 19.8.44. Accepted: 10.1.47.

Improvements in the Production of Composite Materials. J. Graham and H. A. Hirst. To: Dunlop Rubber Co., Ltd.

Composite material produced by contacting a layer of parallel wires with a textile fabric containing fusible and less fusible threads and subjecting this assembly of wires and textile to pressure at a temperature sufficiently high to allow fusion of the threads, but not high enough to affect the fusible properties of the less fusible threads. The fusible threads are composed of a copolymer of vinyl chloride and vinyl acetate, and the less fusible threads consist of nylon.

B.P. 584,309. Application date: 19.1.44. Accepted: 13.1.47.

Production of Polymerization Products of Ethylene. To: Imperial Chemical Industries, Ltd. Communicated by E. I. Du Pont de Nemours and Co.

Manufacture of telomers and polymers or interpolymers of ethylene by liquifying ethylene and subsequently subjecting it alone or together with a telomerizing or interpolymerizing constituent to elevated pressure and temperature in the presence of oxygen or a peroxide catalyst.

B.P. 584,317. Application date: 12.6.44. Convention date (U.S.A.): 10.6.43. Accepted: 13.1.47.

Improvements in Uniting Textile Fabrics or other Sheet Materials by means of a Thermoplastic Substance. To: British Celanese, Ltd.

This specification describes the application of the well-known sewing machine to the uniting of textile fabrics or sheet materials by means of local application of heat. At least one of the materials consists of or contains a thermoplastic film-forming substance, and a heated reciprocating element built into the sewing machine pierces the assembly of sheet materials and withdraws afterwards. The thermoplastic material around the edge of each perforation is fused and this provides a spaced bond holding the materials together.

B.P. 584,324. Application date: 26.7.44. Accepted: 13.1.47.

Improvements in or relating to Ethylene Interpolymers. R. B. Richards, J. R. Myles and D. Whittaker. To: Imperial Chemical Industries, Ltd.

Manufacture of interpolymers from ethylene and diesters or ethers of unsaturated alcohols, for example, diallyl esters of di-basic acids, by subjecting ethylene and a divinyl or diallyl ester of a saturated dicarboxylic acid or divinyl or diallyl ether, to elevated temperature and pressure in the presence of oxygen or a per-compound.

B.P. 584,428. Application date: 4.8.43. Accepted: 15.1.47.

Improvements in or relating to the Polymerization of Hydrocarbons. Communication from: Standard Oil Development Co.

Refers to the manufacture of olefin polymers suitable for the manufacture of motor fuels, and in particular for the production of safety fuels for aviation purposes. Aliphatic hydrocarbon materials containing at least 5 per cent. of isobutylene are treated in a gaseous phase with gaseous boron fluoride as a catalyst for a period of less than a second; subsequently the product containing a major proportion of tri-isobutylene is separated.

B.P. 584,434. Application date: 24.1.44. Accepted: 15.1.47.

Stabilization of Vinyl Resins. Communication from: W. W. Triggs.

Heat stabilization of copolymers of vinyl halides with dialkyl fumarates, dialkyl maleates or chloromaleates or vinylidene halides by adding organic zinc salts (zinc laurate or zinc stearate).

B.P. 584,437. Application date: 16.3.44. Convention date (U.S.A.): 1.2.43. Accepted: 15.1.47.

Improvement in Plasticized Vinyl Copolymer Resin Yarns, Fabrics and other Textile Articles. T. A. Feild, Jnr. To: Carbide and Carbon Chemicals Corp.

B.P. 584,548. Application date: 28.7.44. Convention date (U.S.A.): 28.7.43. Accepted: 17.1.47.

Improvements in or relating to the Spinning of Filaments of Acrylonitrile Polymers. To: Imperial Chemical Industries, Ltd.

Wet-spinning of acrylonitrile polymers in order to obtain filaments possessing high tenacity, good elongation and lustrous

appearance. The process comprises extrusion of a solution of the acrylonitrile polymer in a volatile organic solvent into a spinning bath consisting of an aqueous solution containing 30-50 per cent. of calcium chloride heated to approximately 100 degrees C. and passing the filaments through the bath until they are substantially coagulated. The volatile organic solvent is dimethyl formamide.

B.P. 584,561. Application date: 1.1.45. Convention date (U.S.A.): 30.12.43. Accepted: 17.1.47.

Improvements in or relating to Synthetic Linear Polyamides. To: E. I. Du Pont de Nemours and Co.

Manufacture of N-methylol polyamides by reacting formaldehyde with synthetic-linear polyamides.

B.P. 584,607. Application date: 15.4.43. Accepted: 20.1.47.

Process for the Preparation of Methacrylic Acid and its Esters. C. Weizmann.

Divided out of B.P. 578,082. Production of methacrylic acid and its esters from alpha-alkoxy-isobutyric acids and their esters by treatment with a dehydrating agent (phosphorus pentoxide, anhydrous oxalic acid or activated alumina).

B.P. 584,613. Application date: 10.1.45. Convention date (U.S.A.): 11.1.44. Accepted: 20.1.47.

Improvements in or relating to the Manufacture of Sulphur-containing Synthetic Linear Polyamides. To: E. I. Du Pont de Nemours and Co.

Refers particularly to synthetic linear polyamides, having extra-linearly attached to the carbon amide nitrogens, mercapto-methyl, or the corresponding disulphide groups. The process comprises the following steps: reacting an N-alkoxy-methyl polyamide or N-methylol polyamide with thio-urea or thio-acetic acid and treating the resulting product with an alkali-metal hydroxide.

B.P. 584,620. Application date: 11.1.45. Accepted: 20.1.47.

Improvements in or relating to Polythene Compositions. E. L. Midwinter and R. B. Richards. To: Imperial Chemical Industries, Ltd.

Thermoplastic composition having a relatively high softening point and toughness, consisting of 70 parts of polythene and 30 parts of calcium carbonate of a particle size below 0.1 micron.

B.P. 584,658. Application date: 19.1.45. Convention date (U.S.A.): 19.1.44. Accepted: 20.1.47.

Improved Transparent Sheets. To: E. I. Du Pont de Nemours and Co.

Production of transparent polystyrene sheets by heating styrene and methacrylic anhydride (1-10 per cent. by weight of the styrene) and .01-1 per cent. of benzoyl peroxide in a cell formed of two sheets which are inert to the above composition and are held by flexible gaskets whilst the edges are sealed by a flexible material, and subsequently placing the cell in an inert liquid bath at a temperature between 50 degrees C. and 90 degrees C.

B.P. 584,662. Application date: 22.1.45. Convention date (U.S.A.): 22.1.44. Accepted: 20.1.47.

Improvements in or relating to the Production of Vinyl Cyanide. To: E. I. Du Pont de Nemours and Co.

Production of vinyl cyanide by reacting hydrocyanic acid and acetylene in the presence of an alkali-metal cyanide catalyst.

B.P. 584,680. Application date: 26.5.44. Accepted: 21.1.47.

Improvements in or relating to Processes of Transferring thermoplastic Materials to Solid Surfaces to be coated, and in/or relating to Methods of forming Seals or Joints. C. R. Oswin. To: British Cellophane, Ltd.

B.P. 584,687. Application date: 4.8.44. Convention date (U.S.A.): 4.8.43. Accepted: 21.1.47.

Improved Interlayer Plies for use in the Production of Laminated Articles and Laminated Articles produced therefrom. To: Imperial Chemical Industries, Ltd.

Improved interlayer ply obtained by polymerizing into a block a composition consisting of 35-65 per cent. of methyl methacrylate, 5-15 per cent. of tetrallyl silicate or tetramethylene silicate, and 30-60 per cent. of a plasticizer, for instance dibutylphthalate, and shearing the ply from this block.

B.P. 584,691. Application date: 18.8.44. Convention date (U.S.A.): 20.8.43. Accepted: 21.1.47.

Production of Improved Interpolymers of Vinyl Chloride and an Ethylene Dicarboxylic Acid Ester. To: E. I. Du Pont de Nemours and Co.

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B.P. 584,742. Application date: 15.1.44. Convention date (U.S.A.): 14.7.43. Accepted: 22.1.47.

Improvements in Copolymers and Methods of making them. F. G. Pearson. To: American Viscose Corp.

Copolymers of acrylonitrile and trifluorochloroethylene.

B.P. 584,794. Application date: 4.3.43. Convention date (U.S.A.): 4.3.42. Accepted: 27.1.47.

Manufacture of Polymers and Interpolymers of Ethylene. To: E. I. Du Pont de Nemours and Co.

Solid, waxy, soft or pastelike polymers and interpolymers of ethylene produced by subjecting a mixture of ethylene and 1-10 per cent. of hydrogen to a temperature between 40-400 degrees C. and pressures exceeding 50 atmospheres in the presence of oxygen or peroxide catalysts.

B.P. 584,795. Application date: 27.3.44. Convention date (U.S.A.): 27.3.43. Accepted: 27.1.47.

Manufacture of Polymers and Interpolymers of Olefines. E. I. Du Pont de Nemours and Co.

Refers to the use of hydrazine or hydrazine derivatives as a catalyst for the production of ethylene polymers or copolymers.

B.P. 584,828. Application date: 26.1.45. Convention date (U.S.A.): 3.12.43. Accepted: 23.1.47.

Hydrolized Interpolymers of Acrylonitrile and Vinyl Esters. To: Imperial Chemical Industries, Ltd.

Refers particularly to oriented fibres and films. The process consists in hydrolizing some or all of the ester groups in interpolymers of acrylonitrile and a vinyl ester (vinyl acetate) in which the molar ratio of acrylonitrile to vinyl ester varies from 1:10-10:1.

B.P. 584,857. Application date: 3.7.44. Accepted: 24.1.47.

Improvements in Bonding Surfaces. D. Starkie and H. Silber. To: Imperial Chemical Industries, Ltd.

Improved cementing composition consisting essentially of butyl methacrylate (n-butyl methacrylate) and 1-30 per cent. by weight of acrylic acid or methacrylic acid.

B.P. 584,875. Application date: 31.1.45. Convention date (U.S.A.): 1.2.44. Accepted: 24.1.47.

Process of Vulcanizing Artificial Rubber-like Masses comprising Conjugated Butadienes. To: E. I. Du Pont de Nemours and Co.

B.P. 584,908. Application date: 27.1.41. Accepted: 27.1.47.

Improvements in the Manufacture of Rubber in Cellular Form. G. M. Hamilton and L. G. Brazier. To: Callender's Cable and Construction Co., Ltd.

B.P. 584,928. Application date: 8.3.45. Accepted: 27.1.47.

Improvements relating to the Manufacture of Artificial Resinous Substances. F. Frank. To: Aspro, Ltd., and British Artificial Resin Co., Ltd.

Production of resins by condensation of an aldehyde with a mixture of urea, thiocarbanilide and a phenol in the presence of a catalyst (hydrochloric acid, ammonia, etc.).

CHEMISTRY AND TECHNOLOGY OF THE ORGANIC ISOCYANATES

(Continued from page 211)

hydrazines to yield substituted semicarbazides.[88] The reaction with aminoacids is said to proceed smoothly only in aqueous alkaline solution[81] (reactions 24 and 25).

These reactions are utilized in organic analysis for the preparation of crystalline derivatives from amines, alcohols and phenols, alkyl and aryl halides and less commonly amino acids.

10. Reaction with Carboxy Acids

This reaction leads to ill-defined products, but there is evidence that substituted amides and anhydrides are formed.[92] Amides result by condensation of one mole each of the reactants, anhydrides and disubstituted ureas by condensation of two molecules each. In all cases CO_2 is liberated (reactions 26 and 27).

11. Reaction with Amides

Amide groups enter into reaction with isocyanates in the same fashion as amino groups. In this case, acyl substituted ureas result (reaction 28).

(To be continued)

Planned Mould Maintenance Service Aids Economical Production

Section XXII (conclusion) By W. M. HALLIDAY

To conclude this series, and continuing the study of tool-room facilities applicable to compression-type plastic moulds several useful fixtures, devices and testing tools are here described. Their object being to enable repairs, inspections and all ordinary handling operations to be conducted with greater speed, ease and reliability.

By their introduction, the general handling of all such moulds, but especially those of excessively heavy weight or bulky proportions, is rendered far safer and less liable to accident and damage to the tools.

Mention is also made of the desirable cursory care which should regularly be bestowed upon certain external portions of moulding press machines, in order to promote still smoother running and easier fitting of the moulds.

The part which the works drawing office may play in promoting more effective maintenance of all types of plastic moulds is also described briefly, to afford guidance in the ways in which co-operation between these two important departments should profitably function.

IN the preceding portion of this section, published last month, consideration was given to the more general maintenance problems and activities associated with the most important and widely used kinds of compression moulds.

The present instalment, which terminates the very lengthy series on the whole subject of plastic mould maintenance, deals with a number of exceedingly useful devices recommended by the author for tool-room use, whereby necessary repair and handling operations on compression moulds can be considerably facilitated.

The objectives behind the application and use of these fixtures are: (1) To render all handling and transporting of heavy or bulky moulds about the tool-room, or from machine to machine, simpler and safer; (2) to enable the maintenance engineer speedily to test certain portions of the mould suspected of damage and requiring replacement or correction; (3) to provide in simple, effective way the means whereby the mould may be operated without actually applying a plastic charge so that the interaction of its various component parts may be better inspected, adjusted and corrected if required; (4) to effect reduction in time and effort formerly incurred in effecting all such repairs.

It will be appreciated that the foregoing objects are extremely desirable ones, and their achievement is worthy of not a little attention and expense in the provision of the proper kind of equipment for such purposes as have been outlined.

As will be understood, compression plastic moulds, whilst not usually being as mechanically intricate as those employed in the injection process, are often very much larger, heavier and more difficult to handle, and it is just because of these features that difficulties arise in the tool-room when such a tool is returned for repairs, etc. Any devices or methods which can economically be instituted to assist the maintenance engineer in such tasks will, therefore, be well worth while, for not only will they permit quicker accomplishment of repairs, but possible damage to moulds will be avoided.

The Adapted Fly-press

In nearly every case of a repair to a compression mould it will be found highly desirable to operate the tool throughout a complete cycle of its movements, either to ascertain the precise nature of a fault, or to ensure that a repair has been properly carried out before the mould can be returned to the production shop.

For such purposes, most tool-rooms are equipped with small fly-presses of the screw-ram type, on to which a mould can

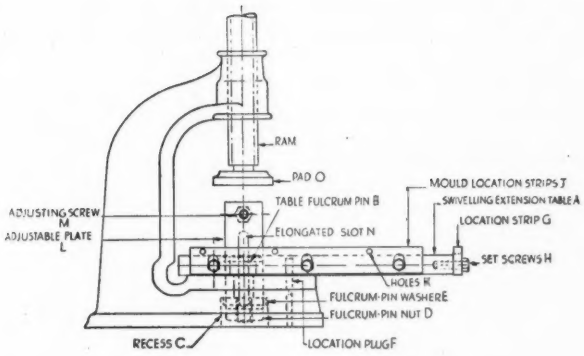

Fig.1.

conveniently be placed and the various force members actuated once or twice. Very few tool-rooms are provided with small, power-operated moulding presses of the experimental type for such duties.

Several serious drawbacks are, however, associated with use of ordinary fly-presses for these purposes. First, the platens are often too small in surface area to permit proper mounting of a large mould and to locate fixing clamps. Secondly, the throat width is often too restricted, thus preventing proper admission of a mould of large overall dimensions. Thirdly, it is often essential for a mould so mounted on a press to be swivelled round to another position during actual testing, which, of course, cannot be performed without releasing clamps and therefore destroying the correct initial setting.

To overcome the foregoing disadvantages, as well as to afford a number of extremely useful advantages, the author has employed, with excellent results, an adapted form of fly-press of the kind about to be described.

This modified form of press is shown diagrammatically by Fig. 1, which provides a good representation of the nature of those modifications and methods of operating the press. Readers will easily appreciate from consideration of this drawing how the many advantages are obtained in an inexpensive manner.

From this illustration, it will be first observed that the adaptation is made to a conventional type of screw-operated fly-press, and it should be noted, too, that the fixture of the necessary additional parts in no wise impairs the effectiveness of the press to perform its normal functions, since the extras can quickly be removed if desired.

Essentially, the adaptation consists of the provision of a special table or plate, so fitted to the platen of press as to be capable of being set in any desired radial position throughout an horizontal plane. This table is extended sufficiently to allow a mould to be withdrawn by simple sliding movements completely away from underneath the ram, or, if required, to be swivelled round again in the horizontal plane, as will be described more fully at a later point in this description.

Referring again to Fig. 1, showing the side view of the adapted fly-press, the auxiliary table or extension platen A may either be a single iron casting or a built-up piece from suitable steel plates. The writer has found steel plates, welded together into a stiff single unit, to be very effective, and less liable to crack or fracture should a heavy mould be accidentally dropped on to the table. On the

other hand, steel plates have the tendency to flex a little, and if a very heavy mould were to be placed thereon some troubles might be encountered because of misalignments with press ram arising from such distortion. Then, too, constantly sliding heavy objects over a steel structure tends to raise burrs and cause scratches, again to the detriment of correct alignments or easy handling.

This auxiliary plate A is then affixed to the platen in such a manner as to allow it to be swivelled around the fixed fulcrum stud B, which latter member, it will be observed, is headed at its top end, this being sunk into a suitable recess in table top, so that it cannot project above top surface of table. The stud at its lower end passes through a hole bored in the press platen, as shown, and in the enlarged recess C, machined from the under side of the press platen, is the special lock-nut D and hardened washer E. Adjustment of these two members is made until the table can be swivelled smartly, but not too easily. The fulcrum stud B is threaded at its lower reduced end to receive this nut, the latter clamping the washer E forcibly against the shoulder formed on the stud for this purpose. When so locked, the stud and table should be free to rotate under hand pressure.

Table Settings

In order to determine the correct position when the extension table is directly square to the machine, a tapered locating plug, as at F, is provided. This member is fitted into a tapered hole drilled through both extension table and press platen. The lower portion of this hole is drilled parallel and serves as a knock-out hole for removing the plug when desired to swivel the table.

By having a number of such tapered holes, it will be possible to determine a number of table settings as required when handling split moulds or transfer tools. Thus, positions as 90 degrees to first setting can readily be obtained. The plug is hardened and ground.

At one end of the table A is attached a location strip G, which may be set in a raised or lower position, relative to the top of the table, by means of the set screws H. These screws pass through elongated holes machined in the strip, thus allowing the latter to be moved sufficiently to bring the top edge of strip below the table-top surface if desired.

Both the long sides of the table A are fitted with location strips, shown at J, which again are capable of being set with their top edges below the top of the table, or raised above it, as shown in the illustration.

Means for Locating the Mould

The purpose of these strips is to provide positive means for locating a mould on the table. Packings are employed to span the space between the sides of the mould block and the inside of the strips. Thus, to position a mould is an extremely simple matter. If desired, greater convenience could be obtained by fixing adjustable lock screws through these strips, using the tapped holes K, as shown.

Another useful adjunct to this attachment is the vertical adjustable plate L, which is fitted so as to slide easily in a shallow slot milled across one side of the table. This plate, it will be noted, is positioned on the vertical centre of the press ram, and at its top end carries the long adjusting screw M. Vertical adjustment of this plate is considerable, and is obtained from the elongated slot N, through which the clamping screw (not indicated) passes into the tapped hole in the side of table A.

The purpose of this vertically adjustable plate is to enable side forces, pads, etc., to be operated when split moulds or side moulds are being tested or repaired.

To the ram is fitted the specially enlarged pad O, normally required for making contact with the top force of a mould. Usually, the contact point of the fly-press ram is too small in diameter to give adequate engagement with the mould.

By means of such a pad, shown at O, it is possible to increase the bearing surface and, at the same time, provide means whereby the top force can be positively secured to the ram. This is achieved by first drilling threaded holes through the pad O, and affixing a stiff plate to the top force having clearance holes at each side, through which clamping screws may be inserted to engage with the tapped holes in O. By this means it will be possible readily to secure the top force to the ram, so that it can be actuated up and down within the mould chase any number of times in exactly the same manner as during actual moulding.

The top surface of the table A is, of course, machined perfectly smooth and flat, and is provided with clamping holes precisely like the press platen on which the mould normally works.

Stand for Holding and Transporting Moulds

One of the chief difficulties encountered in the repair department when dealing with compression moulds of large size and heavy weight, centres around the best means of transporting such tools from one machine to another, or from bench to testing table, etc. Usually, it is not possible to machine the mould (because it is hardened or already possesses too many holes) for tapped holes to facilitate its lifting.

The author advises the provision of a suitable, stoutly built metal stand having a flat top portion, and small, substantial castors or wheels, to enable the whole stand to be easily moved along the floor.

Preferably, the height of such a stand should be adjustable, so that a mould can be easily transferred from the stand to a machine table or press platen. If the stand has to be of a fixed height, however, it is better to make it the same as that of the lower press platen to floor, or in cases where the tool-room press has been adapted in the manner just described, to make the height the same as that of floor to top of auxiliary table. Thus, the mounting of a mould on the press will be a simple matter, consisting of a straightforward sliding movement.

It is also advisable to have the bottom portion fairly heavily weighted and the overall dimensions of the table top of the stand sufficiently large to enable a mould to be moved from stand to press platen without any gap. This will entail an overhang on each side of the table, hence the need for a heavy weight in the base to prevent the stand from tilting.

The top surface of such a stand should be covered with a flat piece of sheet brass, zinc or heavy linoleum, to prevent marking and bruising the polished surfaces of a mould. Clearance holes should also be machined through the top surface of the stand, so that clamping screws can be used to secure a mould fixedly to the stand if required. These holes should be the same size and spacing as those in the press platen.

The surface area of the table top should be large enough to allow for two moulds, or at any rate both forces of a single large mould, for the following reason.

When a fault has been noted on a large compression mould in production, the stand just described would be moved into the moulding shop and brought to the press concerned. The mould would then be removed from the press and slid on to the stand, the whole then being wheeled back to the tool-room. Arriving there, the maintenance toolmaker will find it a great convenience if he can simply remove the top or side forces and lay them alongside the bottom ditto on the same stand. Clamping holes should also be provided in the stand top for holding such additional parts, so that work may be performed on them without fear of their being moved.

Indeed, many repair or adjustment operations can be effected on such a stand as this. A further improvement, admittedly involving more expense in its provision, is to make a stand with the top portion on which a mould has to rest inclinable, yet capable of being locked in any angular position.

Many compression moulds when undergoing repairs, such as repolishing of cavity surfaces, removal of burrs on the cavity walls, extraction of seized ejector plugs, or insert holding sleeves, require tilting at some awkward angle in order that the operator can gain access to the point desired, or the seat of a fault. This can often be secured if the mould can be elevated at one side, hence the usefulness of a tilting attachment for the top of the transporting stand just mentioned.

It will also be necessary to install some simple lock to one wheel of the stand, so that when work is being performed on the mould rigidity is obtained throughout the whole set-up.

Because of the simplicity of such a device, illustrations of same have been omitted. Once readers have grasped the idea and functions of such a stand, it will be a simple matter for them to devise suitably constructed and dimensioned stands to suit their own class and size of mould, factors which to a large extent determine the kind of stand required.

The author is able to assure, however, that provision of a stand of the kind described is well worth while and materially assists in obviating damage to a mould or injuries to an operator, which normally arise when trying to handle heavy moulds without proper equipment.

Incidentally, the author would also recommend the provision of a similar type of table or stand for the use of the mould storekeeper. This stand, however, should be equipped with an elevating table top, so that storage bins or shelves at different heights can be reached simply by raising or lowering the stand top table. Such a piece of apparatus will save considerable worry and delay.

Checking Dowels and Dowel Guide Holes

The next piece of tool-room equipment to be described concerns dowels for compression moulds. Very often such tools have to be returned to the repair department to have their dowels realigned or replaced, or checked over for correct size, freedom from wear, squareness with mould face, and so on.

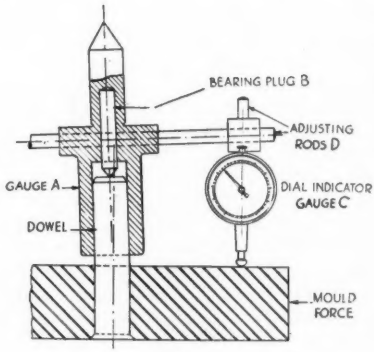

Fig. 2.

Testing such mould members for wear is comparatively simple, but some difficulty is usually encountered when testing for squareness from mould face. The same troubles arise when checking the guide hole in the mating mould block, in which the dowel locates, which part must, of course, be similarly square to mould surface.

Here is described an eminently useful little gauging device which the writer has extensively and successfully employed for such checking operations, and the ensuing description and illustrations will doubtless prove of some guidance to those mould makers and tool-room engineers having to undertake similar corrective measures.

Often in repair work it is necessary for the toolmaker to determine not only the exact amount a dowel or dowel hole is out of square, but also the precise direction of such error. This will arise when the dowels are of large diameter or non-standard size, whose replacement would entail too long a shut-down of the mould, to avoid which the existing dowel or hole must be corrected.

Turning to Fig. 2, which shows the assembled testing device being applied to a distorted dowel, it will be noticed that the gauge consists of an accurately

machined, hardened, combined plug-and-sleeve member A. The plug end is machined to the same diameter as that of the dowel hole to be checked, in which it is made a light push fit. The extreme tip of this plug end is made conical, being very accurately ground and well polished, and brought to a fine, hard point. The reason for this will be shown when describing the use of the gauge.

The enlarged lower end of the plug gauge A is made somewhat larger in outside diameter, and bored to be a snug slip-on fit over the dowel shown. This bore is extended, smaller diameter, for a suitable distance to receive the bearing plug B, which, again, is provided with an accurately ground, hard, conical point, as shown. This plug is made a light press fit within the hole and allowed to project into the larger hole a short distance, as indicated. Again the purpose of this bearing plug will be revealed later.

A dial-indicating gauge, as at C, is secured to the adjustable rods D, which, in turn, are fixed to the gauge body. These rods follow conventional pattern in that they are so attached to each other as to allow the dial indicator to be set in any desired position.

In use, the device is passed on to the distorted dowel in the manner here shown, the bearing plug B being adjusted within its seating hole until the hard point is contacting the end of the dowel, when the lower end-face of the gauge is just clear of the face of the mould block. With the dial indicator set just to contact the mould-block surface, the whole assembly is then slowly rotated on the dowel, noting the deviation of the dial gauge throughout such movement, which will show exactly the amount of bend on the dowel, and also the precise direction of such bend.

If the dowel is perfectly square there will be no deviation of the dial gauge, of course, throughout the complete revolution. Thus, once round of the dial will show clearly just where the dowel has to have pressure applied to produce correct squareness, and the extent of same.

Since the whole gauge is supported on the end of the dowel by means of the hard, conical point of the plug B, even although the end-face of the dowel be inclined due to bend on shank, this will not affect the location of the fixture in any way because of the point contact.

In the case of the dowel-sleeve hole, the gauge is applied with the plug end into the hole being checked, again the hard, conical point engaging the bottom of the hole, or a suitable plug previously inserted therein, and the whole fixture is slowly rotated to note the difference in dial-indicator readings.

The sizes of this gauge will, of course, be made to the most widely used dowel size, and in the case of larger ones standard bushings will be employed to accommodate the gauge.

This will be found an extremely useful little tool, which will save considerable time and guesswork, its use enabling the maintenance engineer very quickly to restore bent dowels to their original degree of squareness and accuracy. Doubtless the idea behind this gauge could be developed for application to other important mould members, thereby effecting savings in inspection, checking and adjusting items.

Cursory Inspection of Moulding Press

Even when a compression mould is maintained in a sound working condition, sometimes it happens that efficient production service is unobtainable because of some mechanical defect or deficiency of the moulding press itself.

In a previous section the author stressed the need for a frequent inspection of the main features of the moulding machine or press, to determine existence of minor faults or unsatisfactory factors which might retard production or interfere with the smooth operation of a mould. Most of the attention was devoted to injection machines, so perhaps it will serve a useful purpose to enumerate a few of the likely points upon which the maintenance engineer could

profitably concentrate his attention when making his regular daily checks on the activities of the mould during its production, as explained in earlier sections.

Troubles often arise because of the wrong adjustment of the press strain rods. The top platen is raised on these rods the requisite distance to allow sufficient daylight for the mould, and one set of lock nuts to platen on the rods may be left slack, or may be adjusted more than the other three, with the result that the whole platen may be slightly misaligned with the surface of the fixed bottom platen. This will be liable to occur where the guide holes in a press platen have been allowed to wear unduly, thus allowing excessive clearance. The remedy for this trouble is rebushing the platen guide holes. Yet in the case of a mould being mounted on a press and found to be stiff in operation, unless the trouble can be located on the mould itself it will be as well to have a glance at the adjusting nuts on the strain rods, and to check these up for correct degree of pressure.

Very similar troubles sometimes develop in respect of the moulding-press stripper rods and the means for adjusting same. Here, again, these rods are usually threaded or passed through a plate at the top end of the stripper cylinder, the other ends passing down through the top moving platen and into the mould. Vibration by working the machine will often loosen the fixing of these stripper rods; in turn, this gives rise to numerous puzzling snags, such as tight mould blocks and difficulty in parting same, distorted moulding, and so on.

Here, again, it will amply repay the visiting maintenance engineer to ensure that these rods are maintained in a locked condition throughout a production run.

In the case of a transfer moulding press, difficulties sometimes arise in respect of the location of the sub-platen and the pot contained therein. Usually, this sub-platen is mounted on short rods suspended from the top platen, or to a bracket mounted on the ends of the strain rods. Some adjustment is provided to enable the sub-platen to be raised or lowered a short distance to meet differing mould-block thicknesses.

Wear or looseness in fixing may cause this sub-platen to become slack and misaligned with the top platen, so that when the mould is in position and the sub-platen brought down to bear on same, the top platen may be tightened in its down-stroke travel, thereby causing a loss of moulding pressure. The maintenance engineer will, therefore, have to give some little attention to the adjustment and setting of this important member of the transfer moulding press.

Mould temperature is also an important factor in successful compression moulding, and many operating troubles can arise whose causes are obscure, but ultimately prove to be due to variations in the heat imparted to platens and mould.

Such variations can, of course, be caused in many ways and, to a large extent, are dependent upon the kind of heating means employed. Where steam is used, as is most often the case, temperature variations can develop from leakages of pipes, valves, steam cocks, etc. On the other hand, blockages in the pipeline or other regulating accessories may cause loss of heat at the critical stages.

Where the maintenance engineer is called frequently to a mould in production which is exhibiting unusual surface-finish conditions on the moulded article, if he cannot trace the cause to the mould he should check up on the supply of heat to the mould. In any case, it is advisable for him, at least once a day, to test the heating apparatus on every moulding press, and at least once a week to see that all surplus condensation in the pipelines is drained off. All valves and stop-cocks should likewise be kept in first-class condition. It should be remembered that leakages at a few points, such as these, may cause a severe drop in steam pressure and heat at the press platen.

If space permitted, the author would

like to describe in similar detail the various other points of maintenance it is desirable to observe in connection with moulding presses, since the association of press and plastic mould in successful moulding production is so intimately connected. This will, however, have to be deferred for a later series of articles. It is hoped that enough has been written to indicate the necessity for the maintenance engineer, when making his regular visit to a mould in production, should bestow a little attention upon the more obvious external features of the press to ensure these, too, are continuing to operate effectively and correctly. If this is regularly done, many puzzling mould difficulties will never arise and numerous worries can be avoided.

Co-operation of Drawing Office with Maintenance

In the earliest sections of this series the author strongly emphasized the need for maintenance, beginning in the drawing office in the form of correct design, structure and selection of mould materials, and as far as possible the standardization of common mould components. Much can be accomplished by this kind of co-operation, and before closing this series the author wishes to mention just one or two of the more important ways in which this may be secured.

The first point to be dealt with concerns the recording of repair activities. As previously explained, very often during repairs a new oversize part has been fitted, or the design of some member has been completely altered. Such information should be passed to the drawing office immediately on completion of the repairs, and steps should be taken to see that it is carefully filed away after all original drawings, stock lists, component-part lists, and so on, have been altered.

In cases where the maintenance engineer has made a rough, free-hand sketch of such modified parts fitted to a mould, the drawing office should take immediate steps to prepare proper blueprints or tracings for their own records, and copies for the guidance of the maintenance engineer. Pencilled sketches on small pieces of paper have the habit of getting lost or mislaid, and often the need arises for the maintenance engineer to refer to the details of a new part fitted to another mould some time earlier, in order to obtain guidance on design, form, size or method of operation. Possession of a properly laid-out drawing will often prove of great convenience and time-saving value.

The second way in which the drawing office can assist is to prepare competent detail sheets for the use of the maintenance engineer. Spaces should be left in which the maintenance toolmaker may enter important dimensions, or other information respecting new parts fitted or required. On completion, these lists are returned to the drawing office and proper drawings, or stock-list requirements, are then made.

The grade of materials used in all moulds should always be clearly indicated on the drawings, and in the case of inability to obtain any special alloy, etc., needed for repair work, the drawing office should insist upon giving the decisions as to what alternative type of materials to use. If this matter is left to the discretion of the mould maker, unsuitable materials may be employed and time wasted.

All datum faces or lines from which essential mould dimensions have to be taken should be plainly indicated on the blue-print, and preferably such faces clearly marked on the finished mould. The reason for this is that, often during a repair, the toolmaker requires to ascertain certain dimensions of the surface where such distances have originated. Finding this out on a complicated mould may entail some time and not a little confusion. If these surfaces are clearly indicated, the toolmaker will be greatly assisted in these directions. The drawing office should co-operate in working out a system of identification for all such sur-

faces, as well as numerous other mould parts, which, if consistently applied to all new moulds, will materially contribute to rapid determination of a fault and its correction.

It has also been found a great help to supply the maintenance department with lists of all standard mould dimensions, such as fixing-hole spacings and sizes, for instance. Capacity charts of the various moulding presses will be found useful for obviating the building of external fixtures, etc., on moulds which are too large to fit within the capacity of the press.

Most mould toolmakers having to conduct repairs will know of a considerable amount of information of a standard character which should be officially recorded and made available to the departments concerned, but here, again, space limitations forbid making any further mention of such points. Enough has been pointed, however, to illustrate the useful results which can accrue from co-operation of this kind between the drawing office and the maintenance department.

Conclusion

Whilst this series has been most extensive, covering the very many aspects of compression- and injection-mould designs, operation and maintenance, the examples and illustrations given throughout have been representative of certain widely used types of mould construction only, and by no means exhaust the vast subject of mould designs and their application.

The main purpose of presenting them, however, has been to indicate that it is just as important to expend skilled effort and attention upon the questions of their effective upkeep and maintenance, as it is for the initial construction of plastic moulds.

It has been stressed throughout that all too often this question of mould maintenance is left unorganized as to methods and proper equipment, with the inevitable result of constantly diminishing production from many such tools. A complete scheme of planned maintenance has been described and illustrated in the greatest detail, and its many benefits plainly recorded as they have been derived from the author's practical experiences.

Maintenance, then, demands careful planning, with constant oversight and inspection of every mould in production; and oversight which duly records every vagary of production usage of the mould, checks the moulded articles being produced at regular and frequent intervals, ascertains the causes of faults before these develop to serious proportions, effects expeditious repairs, and embraces efficient and safe storage of all moulds. From the records thus obtained it is possible to build up a stock of information of great value to the maintenance toolmaker, as also to the mould designer having to evolve new designs; and to the cost accountant charged with determining extent of mould deterioration.

All these aspects have been dealt with, and it is hoped, in a sufficiently adequate manner to indicate their importance and their applicability to any mould-manufacturing and plastic-moulding plant.

The author has been considerably encouraged from time to time by the kindnesses and appreciation shown by many readers in their repeated expressions of agreement and acceptance of the ideas expressed.

THE MICROSCOPIC EXAMINATION OF PLASTIC MATERIALS

(Continued from page 200)

a wood flour consisting in its entirety of individual tracheids, thus using the material in the most efficient manner.

The author would like to take this opportunity of acknowledging his appreciation of the help received from De la Rue Plastics, Ltd., and in particular from Mr. R. B. Harley and Mr. R. R. Rolls, who so kindly carried out all the tests to B.S.S. 117. His thanks are also due to Mr. Deutch and Mr. L. R. Read, of Cellomold, Ltd., who prepared all the experimental powders examined.

(To be continued)

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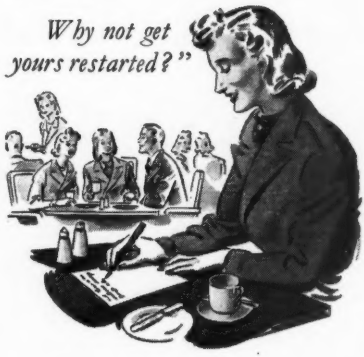

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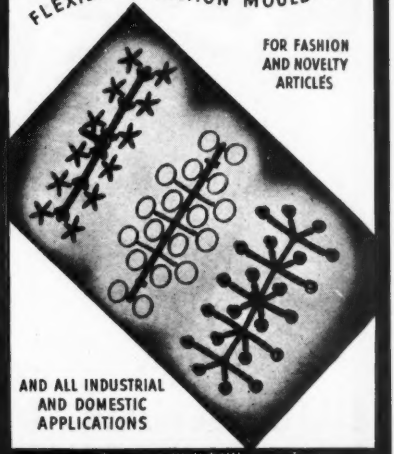

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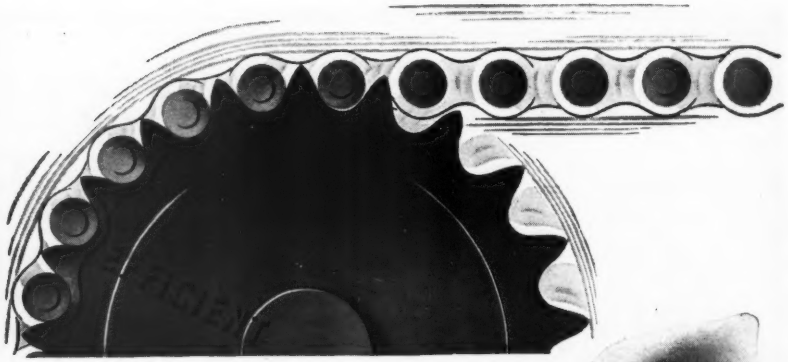

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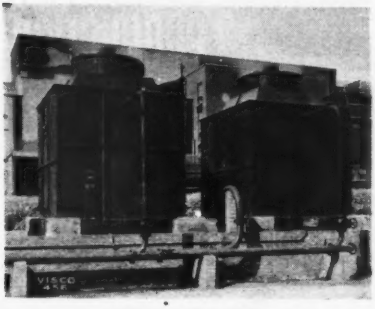

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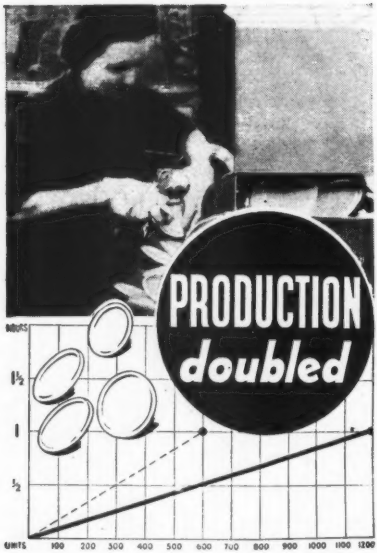

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10-cwt. hydraulic accumulator by Tangye, tank-type, 6 ft. 0 in. diam., 6 ft. 0 in. deep, with three-throw pumps, £250.
Two hydraulic intensifiers by Vickers-Armstrongs (Government surplus), 45 tons w.p. with
Two Vickers motor-driven horizontal hydraulic pumps, direct coupled units, with red. gear, 5 tons w.p., £750 each complete unit.
Immediate delivery ex stock. Really low prices.
HODSON AND CO. (MACHINERY), LTD.,
TOTTINGTON, NR. BURY.
Phone, Tottington 123-4. 119-9546

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IMMEDIATE DELIVERY EX STOCK AT LOW PRICES.

4 ft. 6 ins. double roll edge runner mill, £120.

25 cast-iron Government surplus erecting benches, 9 ft. by 2 ft., fitted six C.I. legs, £15 each only.

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Steele-Shaw A.C. motor-driven paint agitator, £150.

3 1½-in. rotary lacquer or varnish pumps, £30 each.

Two A.C.-driven three-throw vertical tam varnish pumps, £100 each.

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Spiked roll pre-breaker (prev. used asbestos), £200

Complete chromating plant by Canning.

Complete Parkerizing plant.

Selection only from stock. Send your inquiries.

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Four Clicking Presses by B.U.S.M., table 36 by 18 ins., swinging top platen, belt clutch drive, perfect. Box 7218, care of "Plastics." 119-17

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Plastics company near London wishes to meet chemical engineer with knowledge of Hornflowa plastics or similar material. Box 7224, care of "Plastics." 119-20

PRODUCTION CAPACITY AVAILABLE AND WANTED

Pulverizing and grading of raw materials. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-369

Repetition in Ebonite, Erinoid, etc. Capstan lathe work. Mansell, Temple Street, Rugby. 125-8451

Work wanted, tool room available for all sorts of press tools. Press work, assembling, spraying and all sorts of engineering to your design. Universal Components, Ltd., 19 Sunderland Terrace, W.2. Bay 6776.

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119-x182

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We are able to undertake certain small runs of plastic moulded products and individual plastic moulded products. Use our services for the preparation of prototypes in plastics. All inquiries strictly confidential. Cottrell and Co. (Plastic Section), 15-17 Charlotte Street, London, W.1. zzz-394

Cartons.
We are large stockists of new and once-used cartons. Once-used cartons in corrugated and fibre-board are carefully sorted and are in every respect equal to new. We would welcome your inquiries. List upon application.
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We are able to make any quantity of export case. Delivery within 14 days of receipt of order. A sample case is dispatched before purchase, for test and inspection. For the home market we can make cases to your specification from seasoned converted timber without licence.
Wooden boxes measuring 21c by 12½ by 8 always in stock at 2s. 3d. each delivered London or F.O.R. Full tea chests 4s. 6d. each; half chests 3s. 6d. All clean and sound, coopered on uncoopered.
We can supply gummed tape up to three inches width, and can incorporate the trade mark of your company for a charge of 1s. per coil extra.
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Our packing service can accept your goods, pack them, see to documents and place on board ship.
If your problem is packing, consult the specialists,
W. Page and Sons, 34 Langside Crescent, Southgate, London, N.14. Phone, Palmers Green 5087.
Redundant cartons, in first-class condition, purchased for cash. zzz-398

1½-2-oz. Injection Moulding Capacity required; own mould supplied. Box 6667, care of "Plastics." 119-9355

For sale, finely ground material, suitable for the plastics industry; large quantities available. The Oilcakes and Oilseeds Trading Co., Ltd., 108a Cannon Street, London, E.C.4. 119-9357

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119-10

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Urea powder wanted in large or small quantities; offers. Box 6671, care of "Plastics." 119-9354

Perspex Off-cuts, clear and coloured, cut to required size, lactoid rods and all forms of scrap plastic material; immediate delivery. Write, Plastic Department, J. E. Hoare, Byton Chambers, Amen Corner, S.W.17. zzz-399

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 6695, care of "Plastics." zzz-400

Perspex sheets or offcuts required, in clear or colours, any thickness up to ⅜ in. Universal Brush Co., Ltd., Luton, Beds. zzz-407

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Perspex. We are stockists of I.C.I. Perspex. Try us for your requirements of clear and coloured sheets. Cuprex, Ltd., 1-3 Robert Street, Strand, W.C.2. Temple Bar 0902. zzz-405

Urgently required, black acetate sheet .080 in., transparent ruby .030 in. Particulars to Central Engineers, Ltd., 120 Old Street, E.C.1. Phone, Cle 2586. 120-9544

P.V.C. plastic sheetings, 18 ins. by 20 ins. by 2 mm., in various colours and embossed patterns. Supply ex stock. Also ⅝-in. beltings. J. Shepperton and Co., Ltd., 161 Drummond St., W.1. 120-9543

Perspex. Considerable quantities of aircraft scrap Perspex will become available during the next 12 months. Further details on application. Box 7222, care of "Plastics." 120-9738

J. H. Berry (Plastics), Stockist, offer clear and coloured Perspex in standard and non-standard sheets or cut to requirements. J. H. Berry (Plastics), Portland Works, Annesley Woodhouse, Notts. 119-23

Production Capacity Available and Wanted (contd.)

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 129-9541

Urea moulding powder urgently required in pastel shades for export. Send fullest details to Box 7230, care of "Plastics." 121-9737

We have immediate capacity for design of all types plastic moulds and can assist in placing them for manufacture. Write or phone, The Lion Design Service Co., Ltd., 4 Castelnau, Barnes, S.W.13. Riverside 7771. 120-9735

Rod—Casein or Cateline rod required in ½ in. or ⅝ in. diameter. Substantial regular quantities needed, any colours considered. Write in first instance to Box 7302, care of "Plastics." 121-9734

Perspex for sale, new sheets, off-cuts, large and small scrap, clear and colours, in various thicknesses. Box 7217, care of "Plastics." 119-18

Urea, cellulose acetate, polystyrene, phenol moulding powders available in considerable quantities. Apply for details and price to Dunbee, Ltd., 10 Union Court, Old Broad Street, London, E.C.2. Phone, London Wall 2298-9. 119-14

20 thou P.V.C. plastic material, in rolls 36 ins. wide, 70-80 yds. in a roll, price 6s. 1d. per lb. Delivery 7-14 days. Apply Box 7220, care of "Plastics." 119-15

Mail-order house requires articles suitable for mail order, exclusive goods preferred. Box 7223, care of "Plastics." 119-12

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Sheet Perspex. Large quantity of clear, opal, transparent and colours; full-size sheets available from stock immediately at I.C.I. prices, ex works. Send for list. Box 7310, care of "Plastics." 119-1

Perspex fancy goods. Manufacturers have large surplus stocks for disposal at cut prices. Send for list and prices. Box 7311, care of "Plastics." 119-2

Metal powders and oxides. Quotations and samples on application. Dohn, Ltd., 167 Victoria Street, London, S.W.1. zzz-410

Buttons and dress ornaments in plastics. Manufacturers wish to contact home and export buyers with new lines. Box 7208, care of "Plastics." 119-x22

Required, makers-up of sponge bags and other articles from plastic sheeting. Reply, with particulars of experience, if any, to Box 6810, care of "Plastics." 119-12

Injection-moulding capacity available up to ½-oz. shot. Using customers' moulds preferred. Inquiries invited for short and long runs. Box 7361, care of "Plastics." 119-21

SITUATIONS VACANT

Shorthand Typists, Private Secretaries, Clerks, etc. If you are in urgent need of staff, contact Embassy Secretarial Employment Bureau, Excel House, Whitcomb Street, W.C.2. Whitehall 5924. We specialize in efficient personnel. 124-8069

Chemist (Qualified) for research on plastics required by well-known manufacturers near London. Experience in organic and physical chemistry preferred, but not essential. Permanent and progressive positions, with good salary and excellent prospects. State particulars of education, past experience, age and salary required. Strictest confidence assured. Box 7018, care of "Plastics." 119-9542

Chief chemist for electrical industry. Should be fully conversant with all types of varnishes used for insulation, bonding and mica products. Box 7305, care of "Plastics." 120-9736

Sample maker required with experience in buttons and small plastics products for works in Gidea Park. Good wages. Canteen available. Apply Lacrinoid Products, Ltd., Stafford Avenue, Gidea Park, Essex. 119-11

Plastics technologist, qualified, with sound background in chemical and metallurgical engineering, also draughtsman, available. Production and fabrication experience. Knowledge in designing and making moulds by means of electrolytic deposition. Write, stating in which field of plastics interested, to Box 7304, care of "Plastics." 119-7

Traveller required for leather and canvas travel bags and plastic goods. Areas: London, Southern and Northern England. Please write to Box 7129, care of "Plastics." 119-x9695

Production manager required for expansion programme of firm situated near London. Applicants should be chemists or chemical engineers with managerial and administrative abilities, age 30-45. The position is permanent with good prospects for the future and carrying salary with profit participation. Write, in strict confidence, giving full details regarding salary required, age, education and past experience. Box 7362, care of "Plastics." 119-22

SITUATIONS WANTED

Laminated Plastics. Insulation engineer, A.I.E.E., M.Inst.B.E., 16 years' experience plant, materials, processes, testing and research, seeks progressive, responsible post. Available August. Present post technical manager. Box 6994, care of "Plastics." 120-x9354

Laminated plastics. Insulation engineer, A.I.E.E., M.Inst.B.E., 16 years' experience materials, plant, processes, testing and research, desires permanent, progressive and responsible post. Available August. Box 7216, care of "Plastics." 121-9739

Plastics technician (28) seeks progressive position in Scotland, experienced in tool design and production for compression, transfer, injection and extrusion moulding. Good technical qualifications and administrative abilities. Present position, production manager. Box 7303, care of "Plastics." 119-6

Experienced draughtsmen require spare time work, plastic moulds and press tools. BCM/DRAFT. 119-x9593

Advertiser seeks position London or Home Counties. Previously 7 years on 8 oz. injection moulding machines Reed Prentice. Sound knowledge of moulding all powders, including polystyrene; diakon and vinyl chloride, general maintenance and setting up, etc., would represent firm on outside as sales if convenient, or partnership in a small way with anyone interested in plastics. Excellent education, would entertain genuine proposition. Reply, Box 7294, care of "Plastics." 119-x234

TIME RECORDERS

Factory time recorders. Service rental. Phone, Vigilant 4731. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 125-8459

WANTED

Acetate (cellulose) sheeting. Wanted to purchase for cash, any quantity, colour or thickness. Send particulars with samples. Allans, 37 Farringdon Street, London, E.C.4. 119-9352

Acetate sheet and offcuts urgently required in white and pastel shades, up to 8s. 6d. per lb. paid for clean material. Also injection moulding powders urgently wanted, injection moulding scrap and sprew. Powder price paid. Studio Mfg. Co., 169-171 Brearley Street, Birmingham, 19. 119-8314

Scrap plastic material wanted, any quantity. Perspex, Lactoid, Catalin, Acetate, Bakelite, Presspahn. Write, Plastics Dept., J. E. Hoare, Byton Chambers, Amen Corner, Tooting, S.W.17. 124-404

Cellulose sheets or offcuts in 20-60/000 in. thick, in transparent or opaque, urgently required for manufacturing purposes. Box 6899, care of "Plastics." 120-9545

Celluloid, transparent/translucent, or cellulose acetate 25-30/000, required three-four weeks, for manufacturing purposes, preferred in sheets. Box 7308, care of "Plastics." 119-19

Moulds required, suitable for 8-oz. Reed Prentice injection moulding machine, hire or purchase. Apply Box 7219, care of "Plastics." 119-16

Perspex sheets required, any size or colour or thickness. Spot cash. Full details to Box 7221, care of "Plastics." 119-13

Hydraulic presses required. Three each 50, 100 and 150 tons, downstroke, self-contained, fitted electrically heated platens. Of recent manufacture and in new condition. Blackfriars Precision, Ltd., 154 Blackfriars Road, S.E.1. Waterloo 6454. 119-x9966

Wanted, urea powders, in any colour, translucent and opaque, for fabrication, for urgent export orders. Please state quantities offered and price. Box 7186, care of "Plastics." 119-x9923

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermo-plastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-395

Perspex sheet and offcuts wanted, clear and coloured, all thicknesses. Box 6812, care of "Plastics." 119-24

Celluloid sheet or offcuts wanted, thickness 40/1.000-in., ivory white. Offers with sample to A. E. Stokes, 81 Greenway Avenue, Walthamstow, E.17. 119-x368

Prea Decor spraying pistols and parts. Box 7371, care of "Plastics." 119-x309

MISCELLANEOUS

For sale constantly, cut-offs of ⅛ and 1/16 in. natural Holoplast, from 1s. per lb., according to size of pieces. Larks Spraying Process, Monument Hill, Weybridge. 119-x7997

Miscellaneous (contd.)

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4298. 121-9072

Plastic boards, 1/16 in., specially treated, highest artistic finish, suitable for panelling, furniture, bath, splash-backs, etc ; plain colours or marble effect, and wood (oak, mahogany, walnut, etc.), sheets 8 by 4 or cut to requirements. Prompt deliveries. Larks Spraying Process, Monument Hill, Weybridge. 119-x7998

Cartons (surplus), as new, for sale. Various sizes, cheap. Universal Components, Ltd., 19 Sunderland Terrace, London, W.2. 119-9540

Monomarks. Permanent London address. Letters re-directed, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 122-9353

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. 121-9075

Wire lamp-shade frames. Best quality spot welded. Large and small users consult us with your special designs, or send for particulars of our standard designs. D. Potts, Newlongton, Preston, Lancs. 119-x9100

Miscellaneous (contd.)

Plasterboard Huts, second-hand, various sizes, sectional, lined. Ideal for offices, canteens, clubs, etc. Immediate despatch. Write for details to J. Thorn and Sons, Ltd. (Box 124), Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-411

Acetate sheets, 17 ins. by 14 ins., and other sizes, .010 in. thick, regular quantities. Write, G. Foster, 90 Maida Vale, W.9. 119-x64

Perspex (clear), 5 mm., 10½ ins. by 10½ ins., paper protected, 1,500 available from stock. Also seconds Bakelite laminated sheets 1/32 in. to 3/16 in. thick. Jamesons, Pershore Street, Birmingham 5. 119-x9750

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